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Tomoike

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(54) **MOBILE COMMUNICATION SYSTEM AND
A METHOD OF INCOMING CALL
RESTRICTION**

FOREIGN PATENT DOCUMENTS

3-42950 2/1991 (JP) .

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* cited by examiner

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(*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

Primary Examiner—Thanh Cong Le

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(57) **ABSTRACT**

A mobile communication system which can restrict incoming calls to a mobile communication exchange in a traffic congestion state and can omit wasteful processing for connecting a path to a restricting exchange is provide. When a exchange has detected that it is the traffic congestion state, the exchange instruct this state to a location register to indicate that incoming calls to that exchange are to be restricted. When other exchange has received a call request to a mobile station, the exchange acquires information to the location register for the call. When it is found that the location information of the mobile station is the area which is controlled by the incoming call restricting exchange, a call processing for the call is interrupted.

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(58) **Field of Search** 455/423, 424,
455/422, 410, 411, 426, 432, 433, 435,
445

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,085,084 * 7/2000 Christmas 455/411

6 Claims, 3 Drawing Sheets

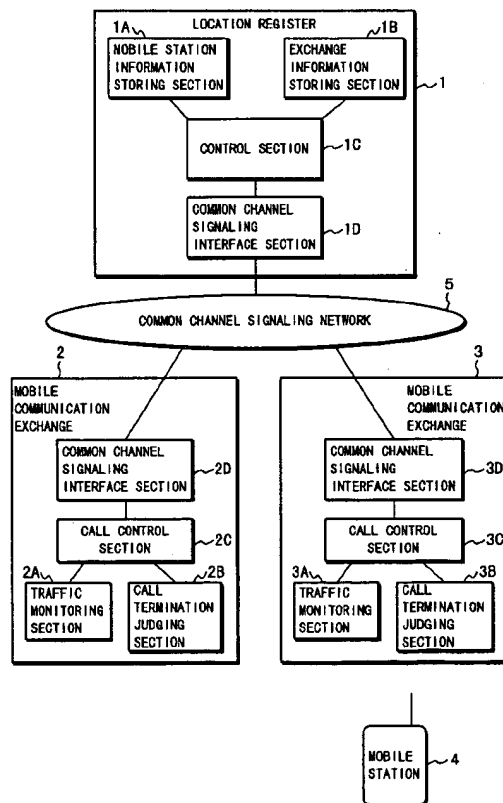


Fig. 1

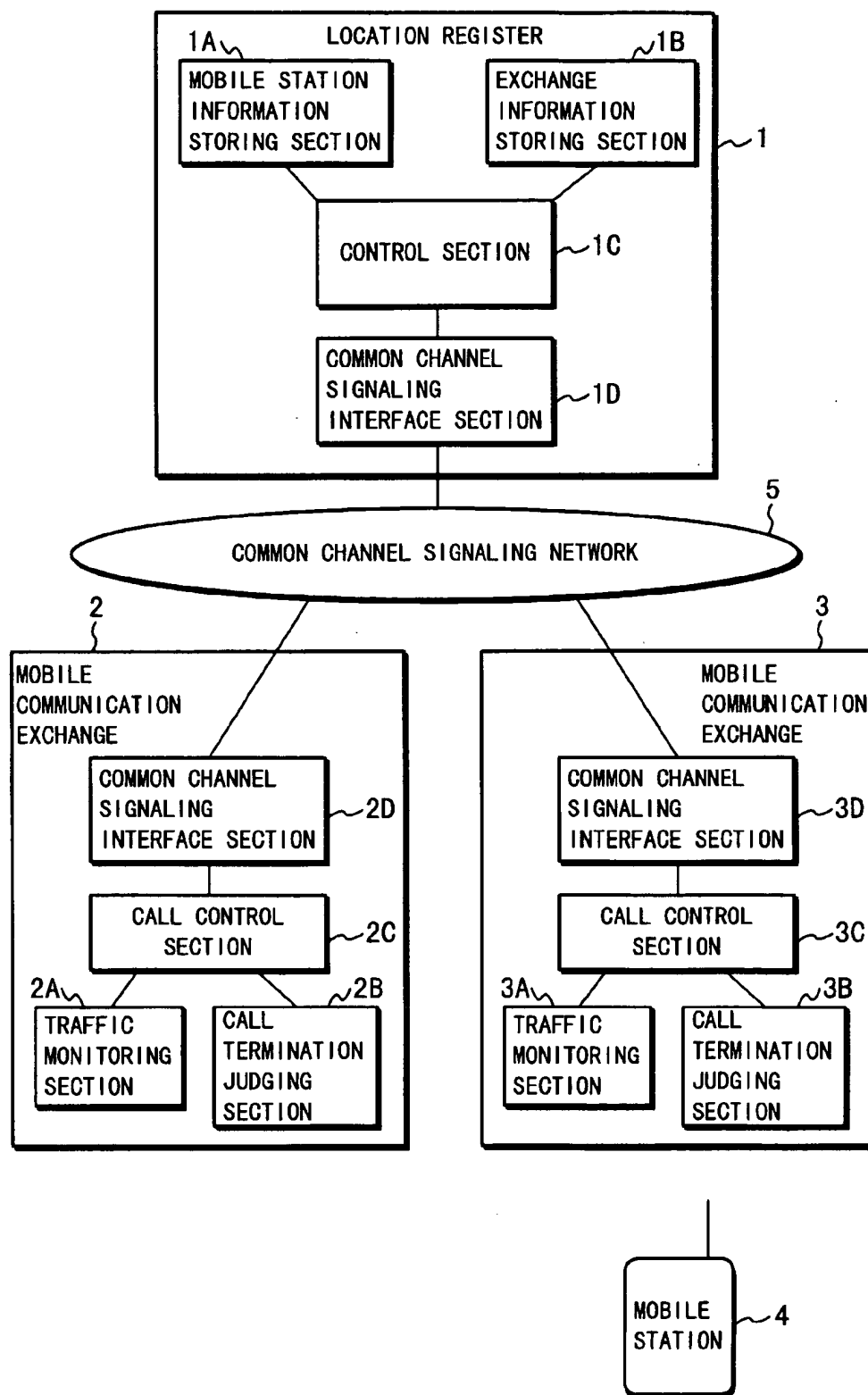


Fig. 2

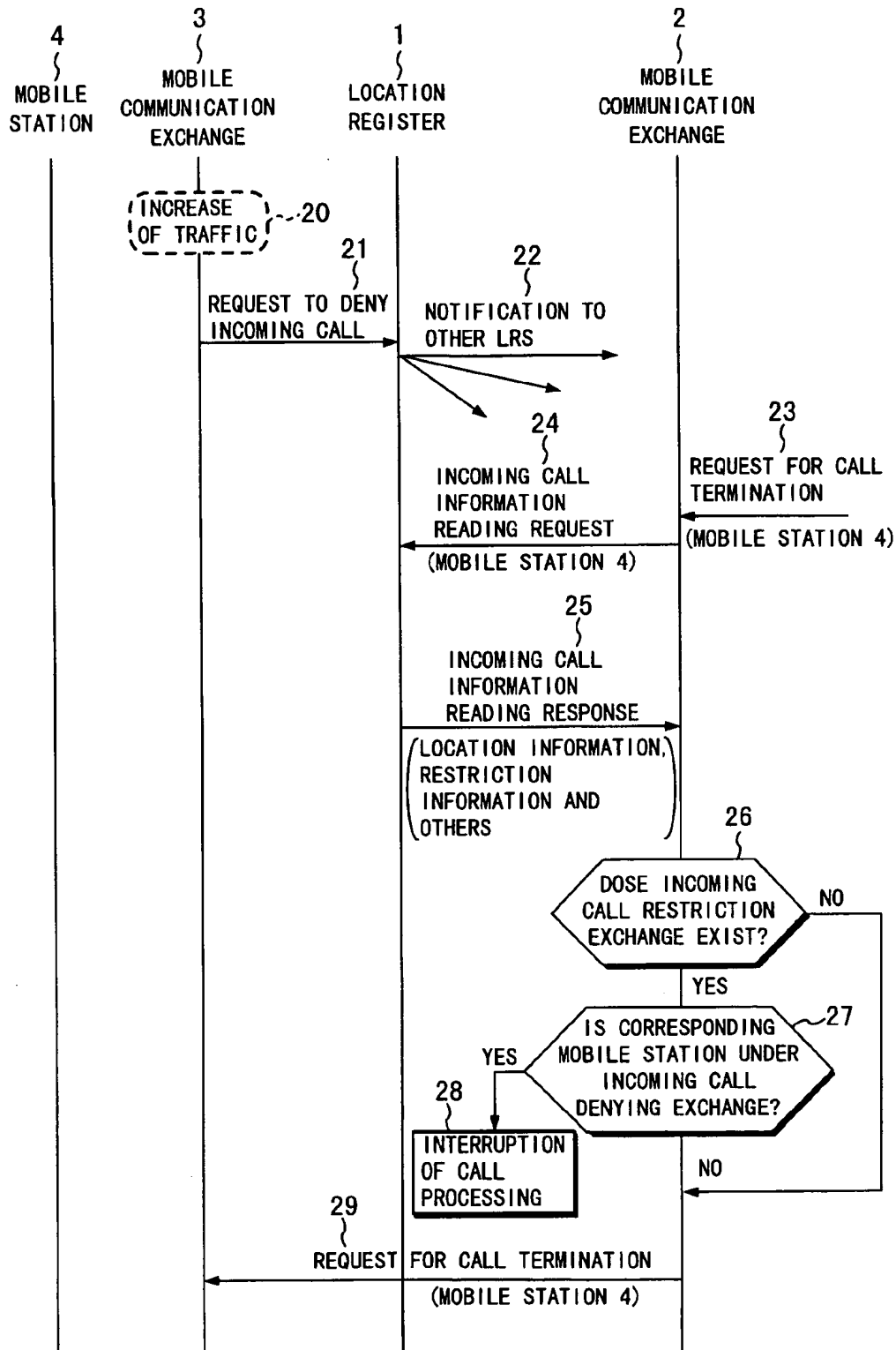


Fig. 3 PRIOR ART

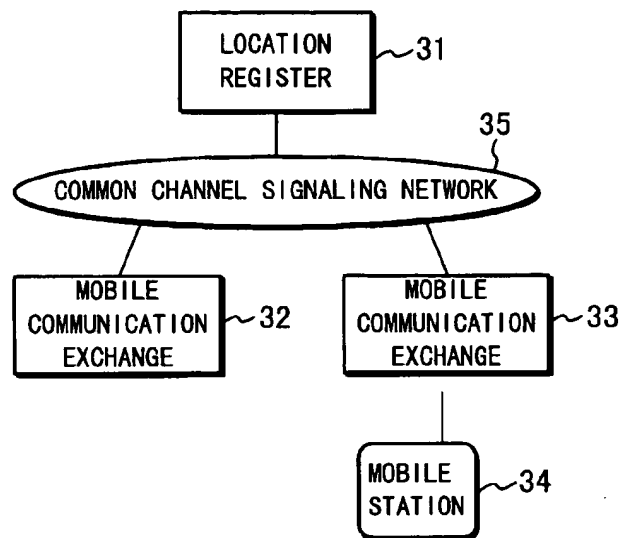
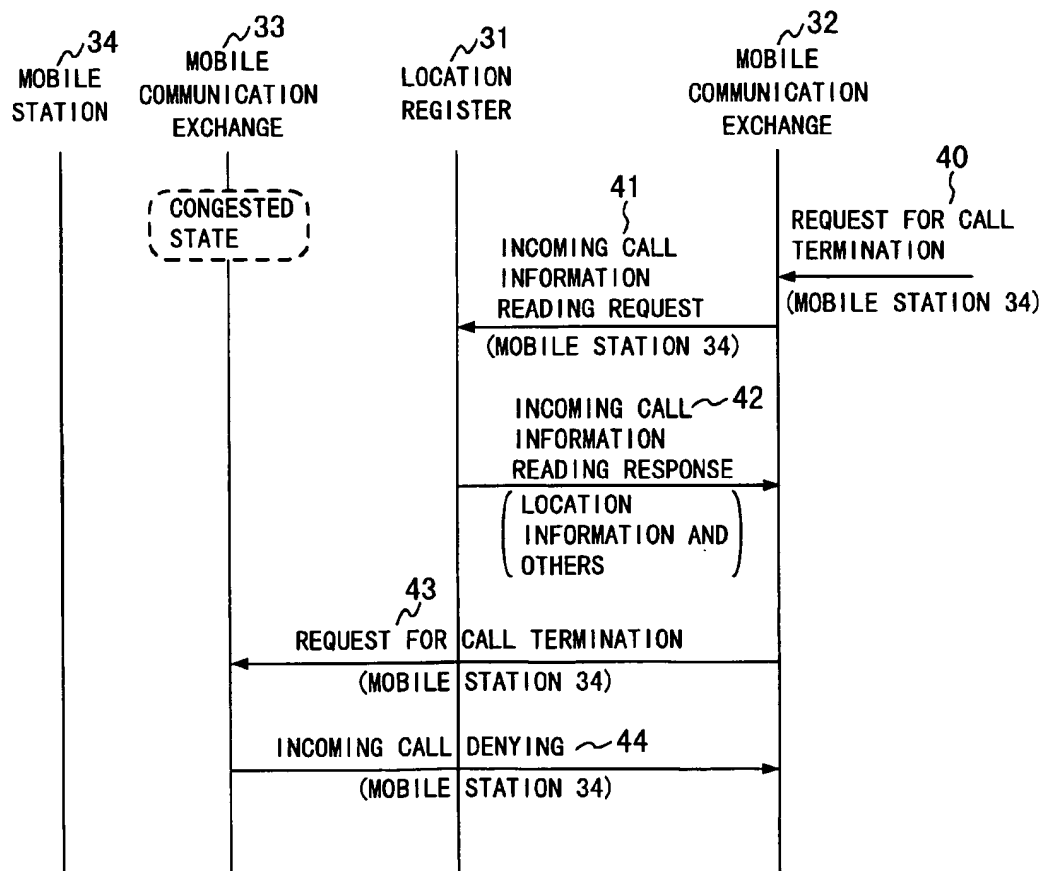


Fig. 4 PRIOR ART



1

MOBILE COMMUNICATION SYSTEM AND A METHOD OF INCOMING CALL RESTRICTION

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a mobile communication system, particularly relates to a mobile communication system and a method for restricting incoming calls when a particular mobile communication exchange is under traffic congestion state.

2. Description of the Related Art

A block diagram of constitution of a general mobile communication system focusing to a network side is shown in FIG. 3.

A location register 31, which manages location information and subscriber information of each mobile station 34, is respectively connected to mobile communication exchanges 32 and 33 for call connecting processing via a common channel signaling network 35 and information required for the processing of an incoming call to each mobile station 34 is mutually communicated via the common channel signaling network 35. Although radio base stations and radio base station control units are not shown in drawings, it is assumed that they are part of the mobile communication exchange 32, 33.

In this type of mobile communication system, if the traffic of a specific mobile communication exchange has increased and congestion state occurs, the specific mobile communication exchange is relieved from such a congestion state by restricting an incoming call to the above mobile communication exchange from other mobile communication exchanges and restricting or denying a call origination request from mobile stations under control of the mobile communication exchange through radio base stations (not shown).

FIG. 4 is a sequence diagram showing a conventional type incoming call control method.

Suppose that the mobile communication exchange 33 which controls the mobile station 34 is in a state of congestion.

At this time, when one of the mobile communication exchanges of the mobile communication network, e.g. the mobile communication exchange 32, receives a request 40 for call termination to the mobile station 34, which is under control of the mobile communication exchange 33, the mobile communication exchange 32 sends an incoming call information reading request 41 to the location register 31 through the common channel signaling network 35.

The mobile communication exchange 32 acquires the location information of the mobile station 34 based upon an incoming call information reading response 42 returned from the location register 31 in response to the above request.

The mobile communication exchange 32 recognizes that the mobile station 34 is located in area under control of the mobile communication exchange 33, and sends a request for call termination 43 to the mobile communication exchange 33.

On the other hand, the mobile communication exchange 33 receives the request 43 for call termination to the mobile station 34, however, as the mobile communication exchange 33 itself is in a state of congestion, the mobile communication exchange 33 returns an incoming call denying signal 44 to the mobile communication exchange 32. Hereby,

2

processing for the call in the mobile communication exchange 32 is interrupted, and the call is treated as a call loss.

However, in such a conventional type mobile communication system, as processing for an incoming call to a mobile station located in an area under control of a mobile communication exchange, which is in a state of congestion, is advanced up to the mobile communication exchange, and the incoming call request is denied by the mobile communication exchange. That is, the mobile communication exchange in a state of congestion is required to execute processing for denying the incoming call. Therefore, such processing for rejecting the incoming call by the mobile communication exchange in a state of congestion causes a problem that a mobile communication exchange in a state of congestion is prevented from recovering from the congestion.

To solve the above problem, Japanese Patent Publication Laid-open No. Hei 3-42950 discloses a technology that incoming calls to an exchange in a state of congestion are rejected at an exchange of the preceding stage which is notified by the exchange in a state of congestion that the exchange is currently being in a state of congestion. Hereby, as incoming calls to an exchange in a state of congestion are restricted at the preceding exchange, the above problem can be solved, however, there is a problem that wasteful processing for incoming calls routed up to the preceding exchange cannot be reduced.

SUMMARY OF THE INVENTION

The present invention is made to solve such problems and therefore has an object to provide a mobile communication system which can restrict incoming calls to an exchange in a state of congestion and can omit wasteful processing for connecting to a restricting exchange.

To achieve such an object, a mobile communication system according to the present invention is constituted so that a location register stores incoming call restricting exchange information showing a mobile communication exchange which is under incoming call restricting state; and a mobile communication exchange, when received a call request, acquires a mobile station information including location information and incoming call restricting exchange information to the location register for the received call request, and verifying whether the call terminating process being allowed or not in accordance with the query result.

In more detail, the location register according to the present invention comprises an incoming call restricting exchange information storage section for storing an exchange information showing a mobile communication exchange is under incoming call restricting state due to traffic over load condition or like, and the mobile communication exchange comprises an incoming call judging section for judging whether a call to a mobile station is allowed or not by referring to information including location information of the mobile station and incoming call restricting exchange information obtained from the location register.

Therefore, each mobile communication exchange comprises means for detecting traffic state of own exchange and instructing the traffic congestion state to the location register, and means for judging whether a call to a mobile station is allowed or not according to information obtained from the location register when a call request has been received, and means for interrupting call processing in accordance with a result of judgement which has judged that the mobile station was located in a control area of the mobile

3

communication exchange indicated by the incoming call restricting exchange information.

A method of incoming call restriction for a mobile communication system according to the present invention comprises the following steps;

- (1) instructing the location register to store an incoming call restricting exchange information when traffic state of a mobile communication exchange exceeding a predetermined value for rejecting incoming calls to mobile stations located in own control area;
- (2) storing the incoming call restricting exchange information in the location register showing that a mobile communication exchange is under incoming call restricting state;
- (3) acquiring information to the location register when a mobile communication exchange has received a call request to a mobile station;
- (4) judging whether a call to the mobile station is allowed or not according to information from the location register including location information of the mobile station and incoming call restricting exchange information; and
- (5) interrupting call processing when it has judged the mobile station is locating in a control area of the mobile communication exchange indicated by the incoming call restricting exchange information.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram showing a mobile communication system equivalent to an embodiment of the present invention;

FIG. 2 is a sequence diagram showing incoming call control processing according to the present invention;

FIG. 3 is a block diagram showing a general mobile communication system; and

FIG. 4 is a sequence diagram showing a conventional type incoming call control processing.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Next, referring to the drawings, the present invention will be described.

FIG. 1 is a block diagram showing a mobile communication system equivalent to an embodiment of the present invention.

The location information and subscriber information of each mobile station 4 are managed by a location register (LR) 1.

The location register 1 is connected to mobile communication exchanges 2 and 3 for executing call connecting processing via a common channel signaling network 5 and information required for the processing of an incoming call to the mobile station 4 is mutually communicated via the common channel signaling network 5.

Although radio base stations and radio base station control units are not shown in drawings, it is assumed that they are part of the mobile communication exchange 2, 3.

The location register 1 is provided with a mobile station information storing section 1A for storing the location information of each mobile station 4, an exchange information storing section 1B for storing exchange information which is restricting incoming calls due to traffic congestion or some other reasons, a control section 1C for executing response processing for a request to acquire mobile station

4

information from the mobile communication exchange, for example, a request to acquire information such as the location information and subscriber information of the mobile station 4, and a common channel signaling interface (I/F) section 1D for providing an interface with the common channel signaling network 5.

The mobile communication exchanges 2 and 3 are respectively provided with call control sections 2C and 3C for executing call connecting processing, common channel signaling interface (I/F) sections 2D and 3D for providing an interface with the common channel signaling network 5, traffic monitoring sections 2A and 3A for monitoring the quantity of their own traffic (traffic intensity), and call termination judging sections 2B and 3B for judging the interruption or the continuation of call processing based upon exchange information under incoming call restriction acquired from the location register 1.

Next, referring to FIG. 2, the operation according to the present invention will be described.

FIG. 2 is a sequence diagram showing an incoming call control method according to the present invention.

The traffic monitoring sections 2A and 3A of the mobile communication exchanges 2 and 3 always monitor the quantity of their own traffic. If the increase of traffic occurs in the mobile communication exchange 3 and the quantity of traffic exceeds a predetermined threshold, the traffic monitoring section 3A notifies the call control section 3C of the situation of traffic and instructs the restriction of incoming call from other mobile communication exchanges and requests of call origination from mobile stations in the own control area. The call control section 3C sends a request to deny incoming call 21 to the location register 1 via the common channel signaling interface (I/F) section 3D and the common channel signaling network 5 if the call control section 3C judges, based upon the notification from the traffic monitoring section 3A, that the restriction of incoming calls is required. When a plurality of location registers are provided in the mobile communication network, the request to deny incoming call 21 is sent to all those location registers.

The request to deny incoming call 21 from the mobile communication exchange 3 is received by the common channel signaling (I/F) section 1D of the location register 1 and notified to the control section 1C. The control section 1C stores information that the mobile communication exchange 3 is restricting incoming calls in the exchange information storing section 1B based upon the notified request to deny incoming call 21.

Afterward, if a request for call termination 23 to a mobile station 4, which is located in the control area of the mobile communication exchange 3, is received by the mobile communication exchange 2, the call control section 2C of the mobile communication exchange 2 sends an incoming call information reading request 24 including the mobile station identification number of the mobile station 4 to the location register 1 to obtain the location information of the mobile station 4.

The location register 1, which has received the incoming call information reading request 24, returns an incoming call information reading response 25 to the mobile communication exchange 2 as a response on the basis of information stored in the mobile station information storing section 1A and the exchange information storing section 1B. Therefore, the location information of the mobile station 4, and also information of exchanges which are under incoming call restriction are included in the incoming call information reading response 25.

5

The call termination judging section 2B of the mobile communication exchange 2, which has received the incoming call information reading response 25, analyzes an incoming call based upon the location information of the mobile station 4 and incoming call restriction exchange information whether the incoming call is to be processed or interrupted.

First, a judgement 26 is made as to whether any of exchanges under incoming call restriction exist or not.

As the mobile communication exchange 3 is restricting incoming call ("YES" in the judgment 26), next, a judgement 27 is made as to whether the mobile station, to which the incoming call is supposed to be terminated, is located in the control area of the incoming call restriction exchange or not.

In this case, as the mobile station 4 is located in the control area of the mobile communication exchange 3 which is currently restricting incoming calls ("YES" in the judgment 27), it has judged that call connecting processing cannot be continued, and notification thereof is made to the call control section 2C. In response, the call control section 2C decides not to send a request for call termination to the mobile communication exchange 3 and carries out interruption 28 of processing for the incoming call to the mobile station 4.

Therefore, as the request for call termination is not sent to the mobile communication exchange 3 under state of congestion, the load of wasteful processing caused by a request for call termination in the mobile communication exchange 3 can be prevented from being increased and delay in the recovery from congestion can be reduced.

If the mobile station 4 is not located in the control area of the mobile communication exchange 3 of incoming call restriction in the judgment 27 ("NO" in the judgment 27) and if no mobile communication exchange which is restricting incoming calls exists in the judgment 26 ("No" in the judgment 26), the call termination judging section 2B judges that call control processing can be continued. Hereby, the call control section 2C sends a request for call termination 29 to the mobile communication exchange 3 under which a mobile station 4 exists.

As described above, according to the present invention, as information of mobile communication exchange which is restricting incoming calls is stored in a location register which is managing the location information of each mobile station, and is notified to a mobile communication exchange which has inquired information for a mobile station to which an incoming call is to be terminated, the incoming call to the mobile communication exchange in a state of congestion can be rejected at the mobile communication exchange which has firstly received a request for the call.

Therefore, the increase of the load of wasteful processing for a mobile communication exchange in a state of congestion can be avoided, delay in the recovery from a congested state can be reduced and the resources of the whole mobile communication network can be efficiently utilized.

Although the present invention has been fully described by way of the preferred embodiments thereof with reference to the accompanying drawings, various changes and modifications will be apparent to those having skill in this field. Therefore, unless these changes and modifications otherwise depart from the scope of the present invention, they should be construed as included therein.

What is claimed is:

1. A mobile communication system provided with at least one location register for managing mobile station informa-

6

tion such as location information of each mobile station and subscriber information and a plurality of mobile communication exchanges for executing call connection processing by mutually communicating mobile station information with said location register via a common channel signaling network, wherein:

said location register comprising an incoming call restricting exchange information storage section for storing an exchange information showing a mobile communication exchange being under incoming call restricting state; and

said mobile communication exchange comprising a call processing section for acquiring a mobile station information including location information and incoming call restricting exchange information from said location register for a call being processed, and interrupting a call processing of said mobile communication exchange under incoming call restricting state based on said mobile station information and incoming call restricting exchange information.

2. A mobile communication system provided with at least one location register for managing mobile station information such as location information of each mobile station and subscriber information and a plurality of mobile communication exchanges for executing call connecting processing by mutually communicating mobile station information with said location register via a common channel signaling network, wherein:

said location register comprising an incoming call restricting exchange information storage section for storing an exchange information showing a mobile communication exchange being under incoming call restricting state; and

said mobile communication exchange comprising a traffic monitoring section for monitoring traffic state of own mobile communication exchange and instructing said location register to store the incoming call restricting exchange information when traffic state exceeding a predetermined value for rejecting incoming calls to mobile stations located in own control area, and an incoming call judging section for interrupting a call processing of said mobile communication exchange under incoming call restricting state based on said mobile station information and incoming call restricting exchange information from said location register.

3. A mobile communication system according to claim 2, wherein; said incoming call judging section judging a call process to be denied when the mobile station being located in a control area of the mobile communication exchange indicated by the incoming call restricting exchange information.

4. A mobile communication system comprising:

at least one location register for managing mobile station information, such as location information of each mobile station and subscriber information, and storing an exchange information showing a mobile communication exchange being under incoming call restricting state;

a plurality of mobile communication exchanges for executing call connecting processing by mutually communicating mobile station information with said location register via a common channel signaling network, and each mobile communication exchange comprising:

a traffic monitoring section for monitoring traffic state of own mobile communication exchange and instructing said location register to store the incoming call restrict-

7

ing exchange information when traffic state exceeding a predetermined value for rejecting incoming calls to mobile stations located in own control area;

an incoming call judging section for interrupting a call processing of said mobile communication exchange under incoming call restricting state based on said mobile station information by acquiring result information including location information of the mobile station and incoming call restricting exchange information from said location register; and

a call processing section for interrupting call processing in accordance with a result of judgement of said incoming call judging section which has detected the mobile station being located in a control area of the mobile communication exchange indicated by the incoming call restricting exchange information.

5. A method of incoming call restriction for a mobile communication system provided with at least one location register for managing mobile station information such as location information of each mobile station and subscriber information and a plurality of mobile communication exchanges for executing call connecting processing by mutually communicating mobile station information with said location register via a common channel signaling network, said method comprising steps of:

storing incoming call restricting exchange information in said location register showing a mobile communication exchange which is under incoming call restricting state;

acquiring a mobile station information including location information and incoming call restricting exchange information from said location register when a call request being received; and

interrupting a call processing of said mobile communication exchange under incoming call restricting state based on said mobile station information and incoming

8

call restricting state based on said mobile station information and incoming call restricting exchange information.

6. A method of incoming call restriction for a mobile communication system provided with at least one location register for managing mobile station information such as location information of each mobile station and subscriber information and a plurality of mobile communication exchanges for executing call connecting processing by mutually communicating mobile station information with said location register via a common channel signaling network, said method comprising steps of:

instructing said location register to store an incoming call restricting exchange information when traffic state of a mobile communication exchange exceeding a predetermined value for rejecting incoming calls to mobile stations located in own control area;

storing the incoming call restricting exchange information in said location register showing a mobile communication exchange being under incoming call restricting state;

acquiring information to said location register when a mobile communication exchange has received a call request to a mobile station;

judging whether a call to the mobile station being allowed or not by acquiring result information including location information of the mobile station and incoming call restricting exchange information from said location register; and

interrupting call processing when it has judged the mobile station being located in a control area of the mobile communication exchange indicated by the incoming call restricting exchange information.

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United States Patent [19]
Sanchez

[11] **Patent Number:** **6,091,949**
 [45] **Date of Patent:** **Jul. 18, 2000**

[54] **LOCATION TRIGGERED BARRING OF CALL FORWARDING**

[75] Inventor: **Juan Antonio Sanchez**, Madrid, Spain

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[22] Filed: **Jun. 25, 1998**

[51] Int. Cl.⁷ **H04Q 7/24; H04M 1/64**

[52] U.S. Cl. **455/417; 455/410; 455/414; 455/433; 455/440; 455/26.1; 455/31.1; 379/210; 379/211; 379/212**

[58] Field of Search **455/417, 410, 455/414, 433, 438, 440, 26.1, 31.1; 379/210, 211, 212**

[56] **References Cited**

U.S. PATENT DOCUMENTS

| | | | |
|-----------|---------|-------------------|---------|
| 5,018,194 | 5/1991 | Suzuki et al. | 379/207 |
| 5,195,131 | 3/1993 | Sano | 379/211 |
| 5,347,574 | 9/1994 | Morganstein | 379/210 |
| 5,440,623 | 8/1995 | Moore et al. | 379/67 |
| 5,577,103 | 11/1996 | Foti | 379/59 |
| 5,610,973 | 3/1997 | Comer | 379/59 |
| 5,657,382 | 8/1997 | Tamagawa et al. | 379/211 |
| 5,815,808 | 9/1998 | Valentine | 455/414 |
| 5,873,034 | 2/1999 | Alperovich et al. | 455/432 |
| 5,878,338 | 3/1999 | Alperovich et al. | 455/417 |
| 5,933,774 | 8/1999 | Bertocci | 455/417 |
| 5,978,673 | 11/1999 | Alperovich et al. | 455/417 |

FOREIGN PATENT DOCUMENTS

| | | | |
|---------|---------|------|-----------|
| 9629839 | 9/1996 | WIPO | H04Q 7/38 |
| 9634502 | 10/1996 | WIPO | H04Q 7/24 |
| 9747152 | 12/1997 | WIPO | H04Q 7/38 |
| 9826620 | 6/1998 | WIPO | H04Q 7/00 |

OTHER PUBLICATIONS

Mitsubishi Electric Corp. Abstract "Mobile Communication System for Inter Mobile Network Communications . . .", Accession No. 97-464654, Aug. 15, 1997.

GPT LTD Abstract "Telecommunications System With Interconnected Networks . . .", G. P. Boot et al.; Accession No. 96-211790, May 23, 1996.

Siemens AG Abstract "Telephone Call Diversion Procedure . . .", T. Lehmann; Accession No. 96-000785, Nov. 12, 1995.

Motorola Inc. Abstract "Telephone Subscriber Equipment User Location Method . . .", J. M. Gilbert et al., Accession No. 95-016432, Dec. 2, 1994.

Nippon Telegraph & Telephone Corp. Abstract "Call Reception Transfer System for Mobile Communication Systems . . .", Accession No. 96-348659, Jun. 21, 1996.

Accessline Technologies Inc. Abstract, "Computer Controlled Paging and Telephone Communications System . . .", R. P. Berg, et al., Accession No. 96-188708, Mar. 28, 1996.

Siemens AG Abstract "Incoming Call Handling Method for Mobile Communication Network . . .", K. F. Neubauer et al., Accession No. 96-355040, Aug. 1, 1996.

NEC Corp. Abstract, "Economic Communication Control in Multi Processing System . . .", Accession No. 94-282356, Jul. 26, 1994.

Anonymous Abstract "Context-Dependent Script for Integrated Communication Services . . .", Accession No. 91-080164, Feb. 25, 1991.

Anonymous Abstract "Directory Service for Integrated Communication Service System . . .", Accession No. 90-122894, Mar. 25, 1990.

(List continued on next page.)

Primary Examiner—Lee Nguyen

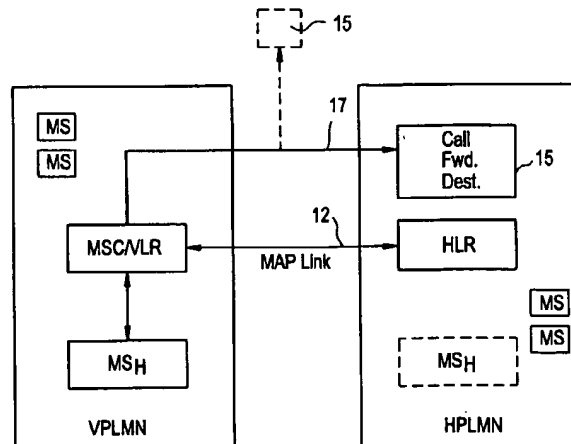
Assistant Examiner—Simon Nguyen

Attorney, Agent, or Firm—Jenkins & Gilchrist, P.C.

[57] **ABSTRACT**

Call forwarding service provided to a wireless mobile communication station is controlled by barring call forwarding from the wireless mobile communication station selectively based on the location of the wireless mobile communication station.

32 Claims, 6 Drawing Sheets



OTHER PUBLICATIONS

Toshiba KK Abstract "Call forwarding Device for PBX Calls Telephone Final Transfer . . . ", Accession No. 87-324214, Oct. 8, 1987.

Fujitsu Ltd. Abstract "Incoming Call Forward Transfer Method by Calling Terminal . . . ", Accession No. 85-300781, Oct. 22, 1985.

Tokyo Shibaura Electric Co. "Call-forward Service Device is Capable of Making . . . ", Accession No. 83-C2786K, Jan. 10, 1983.

FIG. 1

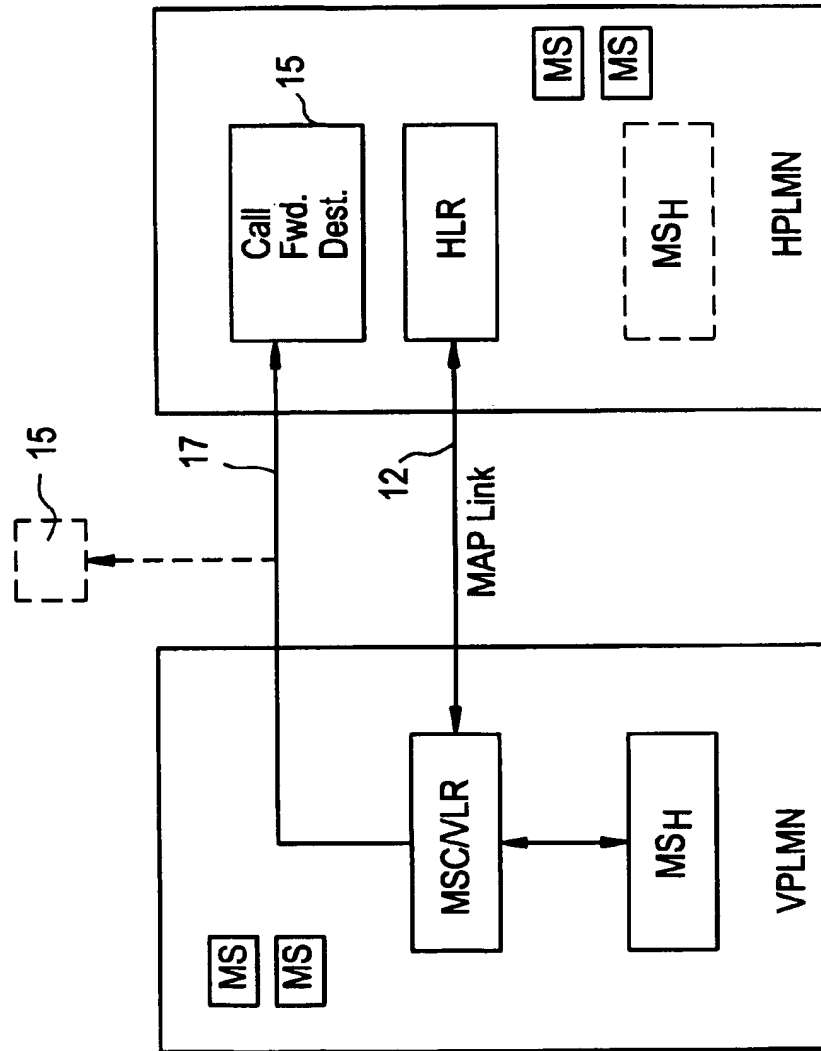


FIG.2

| Mobile station | Area | Barred calls |
|------------------------|--------------------|------------------------------|
| MS 1 MS 2 ⋮ ⋮ | A1 A2 ⋮ ⋮ | Calls 1 Calls 2 ⋮ ⋮ |

25 points to the Mobile station header, 27 points to the Area header, 29 points to the Barred calls header, 21 points to the Mobile station column, and 23 points to the MS 1 and MS 2 entries.

FIG.3

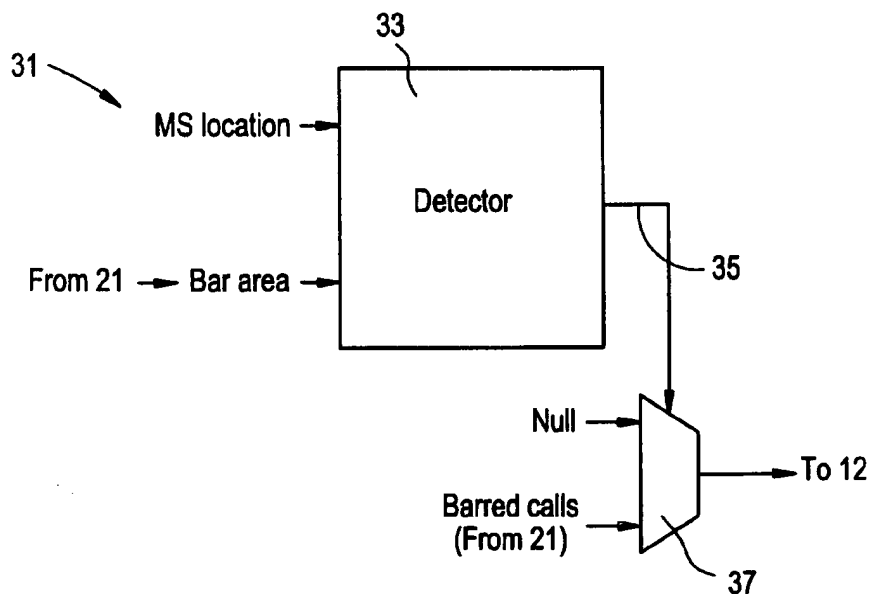


FIG.4

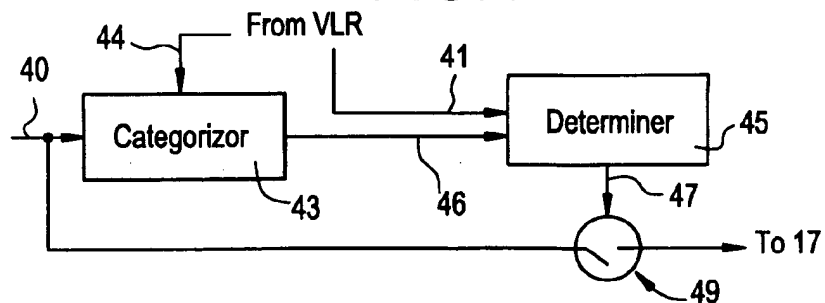


FIG. 5

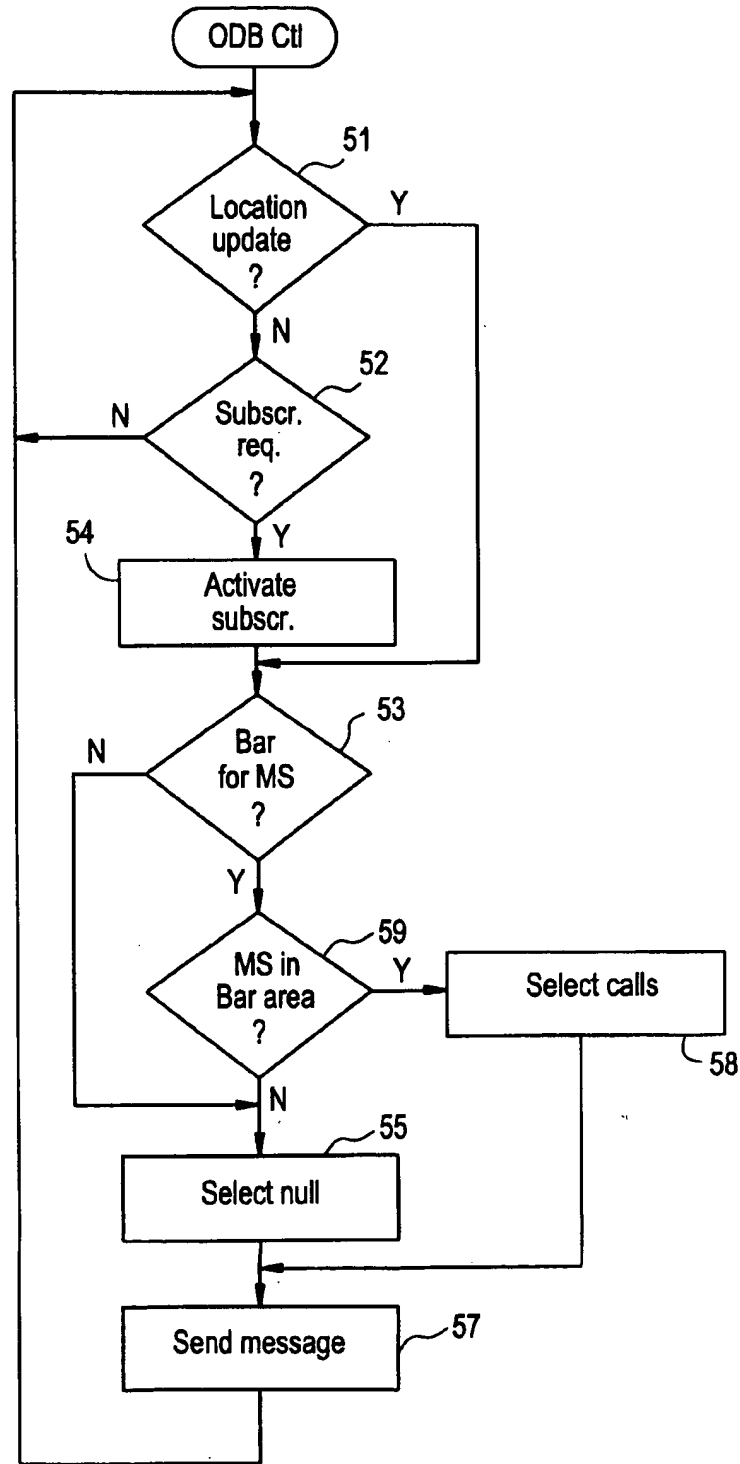


FIG. 6

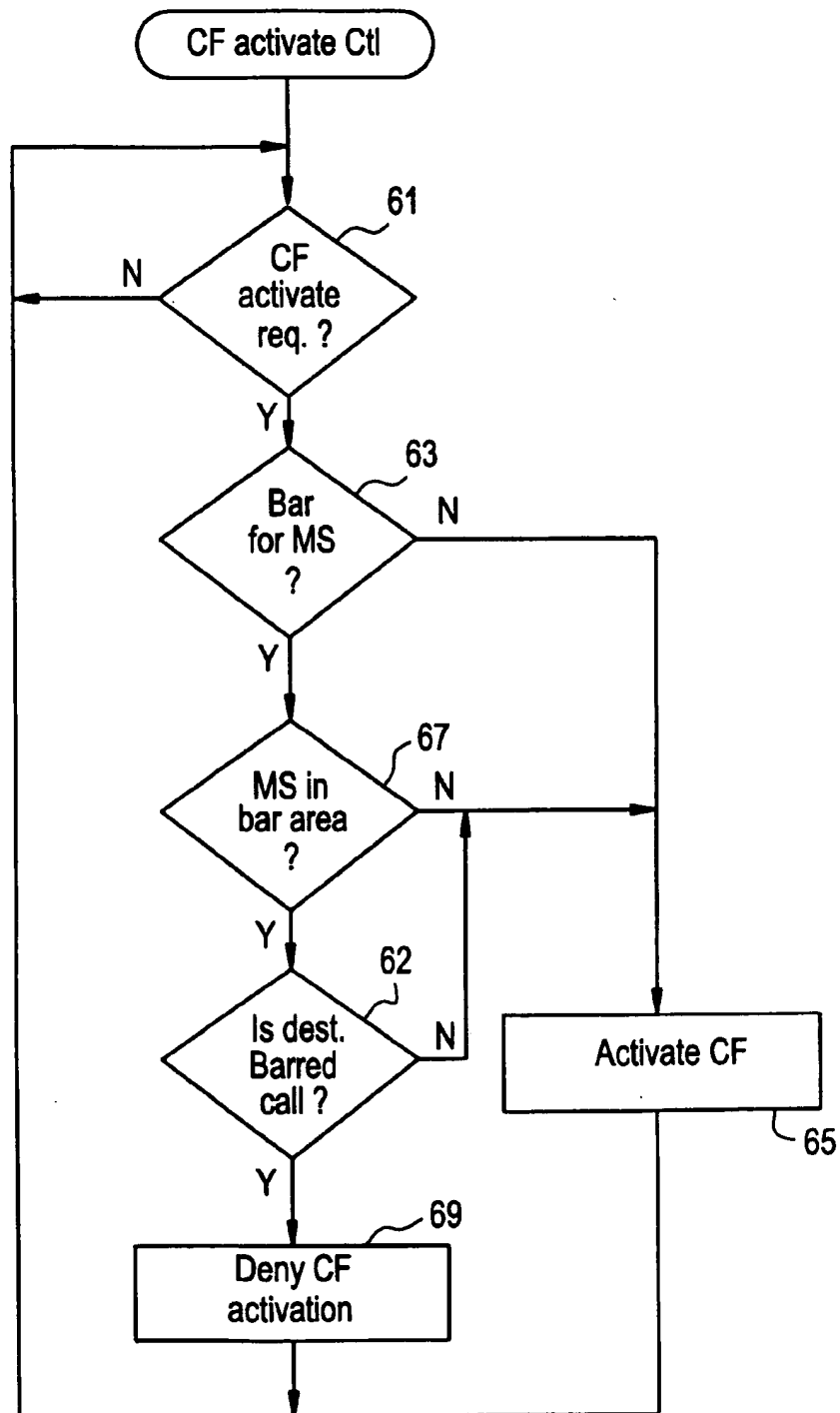


FIG. 7

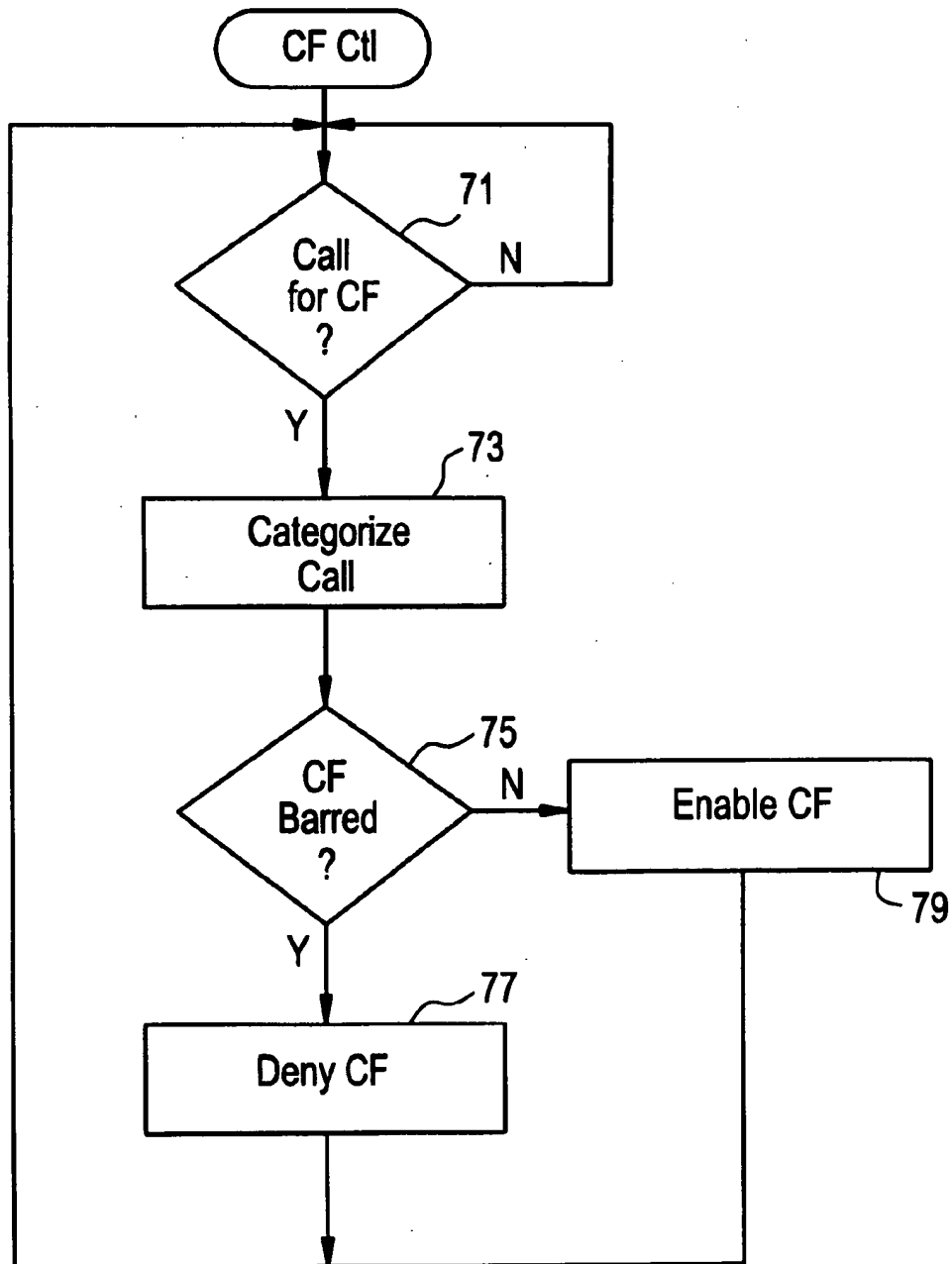


FIG. 8

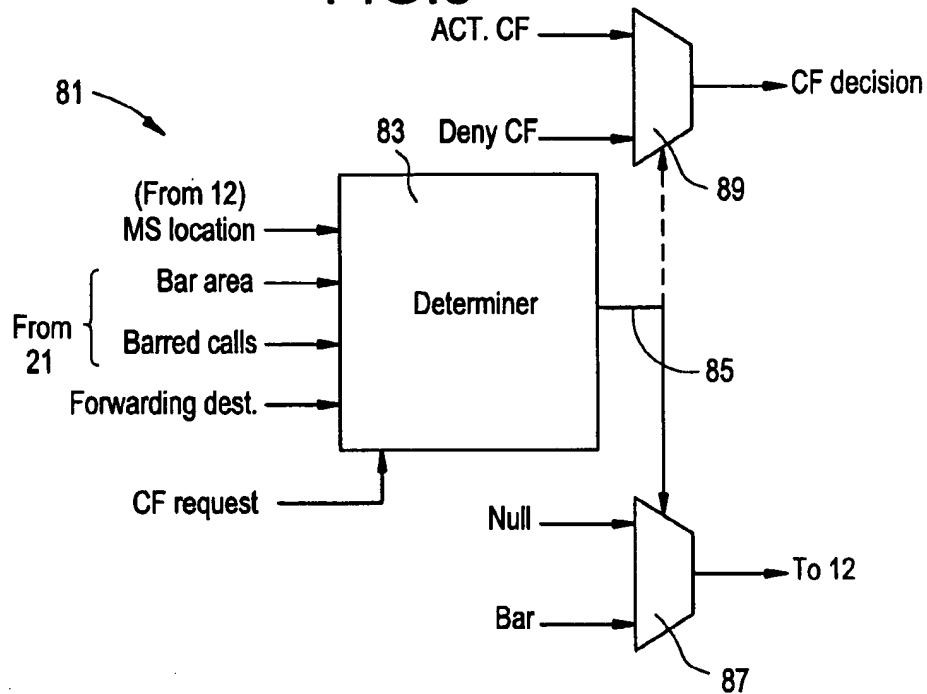
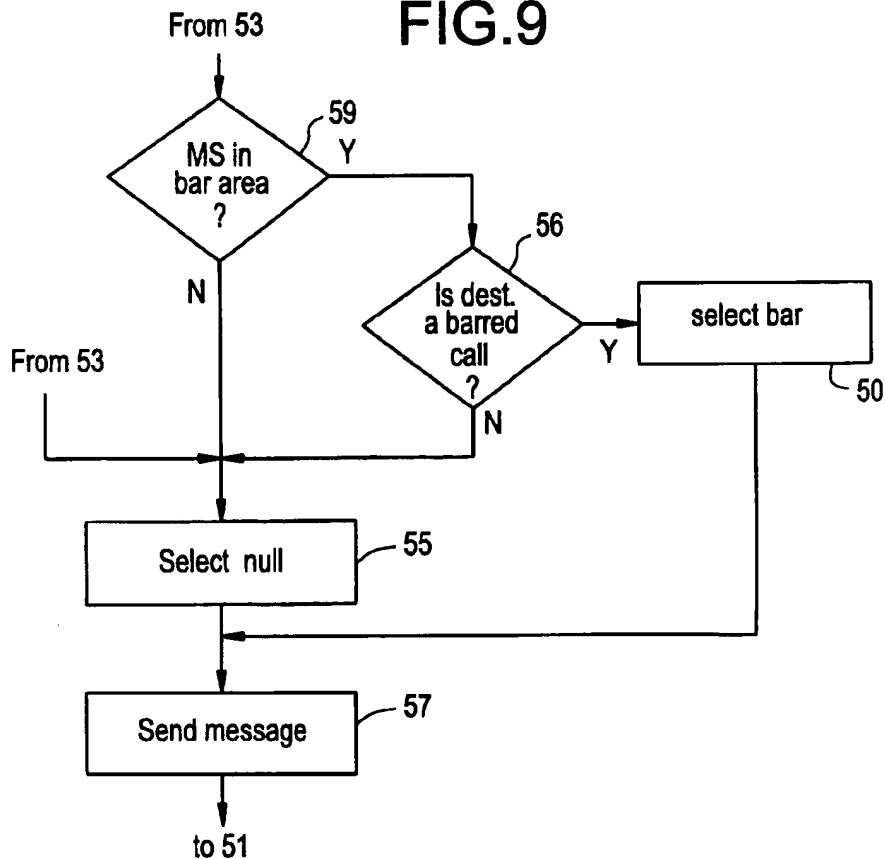


FIG. 9



LOCATION TRIGGERED BARRING OF CALL FORWARDING

FIELD OF THE INVENTION

The invention relates generally to wireless mobile communications and, more particularly, to improvements in call forwarding services provided to wireless mobile communication subscribers.

BACKGROUND OF THE INVENTION

In conventional wireless mobile communications, roaming agreements typically exist between network operators of respective public land mobile networks (PLMNs). Such roaming agreements permit a mobile subscriber unit based in a first PLMN to use the services and facilities of a second PLMN while the mobile subscriber unit is roaming in the coverage area of the second PLMN, outside the coverage area of the first PLMN.

Call forwarding (CF) is one example of a service that a roaming mobile subscriber might wish to use while roaming in the second PLMN. Using the conventional GSM (Global System for Mobile communications) network as an example of the first and second PLMNs, in a conventional GSM network the cost of forwarding (or otherwise deflecting) a call is charged to the mobile subscriber which invoked the forwarding. If the mobile subscriber is roaming internationally, then the forwarding of a call will very likely be charged, disadvantageously, as an international call. Paying international call charges to forward a call is typically very expensive.

Call deflecting service is similar to call forwarding, except the mobile subscriber interactively chooses (on a per call basis) to deflect the call to another destination rather than accept the call, whereas call forwarding services are typically handled in the serving mobile switching center (MSC) without interaction of the mobile subscriber. The problems and inventive solutions disclosed herein apply to both call forwarding and call deflecting services.

Another problem with forwarding the calls of the above-described roaming mobile subscriber is fraud. Call forwarding fraud during roaming occurs when the mobile subscriber uses call forwarding service to forward calls received while the mobile subscriber is roaming internationally, but for which the roaming mobile subscriber does not intend to pay the corresponding international charges. Such fraud can be increased by maintaining several simultaneous calls after invocation of the call forwarding service. The same scenario can occur using call diversion service. This fraud problem is very costly for network operators due to the international signaling links and call legs involved during the calls. In fact, fraud is such a large scale problem that network operators in some countries refuse to provide services such as call forwarding services to mobile subscribers roaming in those countries.

In GSM, there are some conventional mechanisms for cost limitation when the mobile subscriber is roaming. For example, an operator determined bar (ODB) can be applied to outgoing calls originating at the mobile subscriber unit, including calls to be forwarded, such that the invocation of call forwarding services is barred. The ODB in GSM also provides for different restriction levels, for example, barring all calls, all international calls, all international calls except those directed to the mobile subscriber's home PLMN country, all inter-zone calls, or all inter-zone calls except those directed to the subscriber's home PLMN country. However, this solution will disadvantageously bar even

outgoing calls for which the mobile subscriber consciously intends to pay the incurred cost.

Another possible solution to the above-described call forwarding problems is simply for the mobile subscriber to deactivate the call forwarding services. However, the subscriber may well forget to deactivate the services when roaming internationally. Moreover, deactivation of call forwarding does not address the fraud problem described above.

Call forwarding can be barred using conventional Regional Services functionality, but only by disadvantageously deregistering the mobile station from all services to which it subscribes whenever that mobile station enters the service area of a disallowed MSC. Moreover, this type of service must be implemented in the MSC/VLR and can only be used if the Regional Services functionality is implemented in the PLMN where the subscriber is roaming.

Another possible approach would be to use Intelligent Network (IN) architecture to implement services aimed at solving the above-described problems. However, disadvantageously, the Intelligent Network support must be requested in the PLMN where the subscriber is roaming.

It is therefore desirable to provide to a roaming mobile subscriber call forwarding (or deflecting) service with automatically activated security against large, unwanted charges for forwarding/deflecting calls without barring all of the mobile subscriber's outgoing calls.

The present invention provides for selective barring of call forwarding/deflecting services. The selective barring is triggered by the location of the mobile subscriber unit, thereby avoiding the occurrence of many unwanted call forwarding/deflecting charges when the mobile subscriber unit is roaming, and all outgoing calls need not be barred.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates two inter-networked PLMNs including a call forward barring feature according to the invention.

FIG. 2 illustrates an example of a memory and database in the HLR of FIG. 1.

FIG. 3 illustrates one example portion of the HLR of FIG. 1 in greater detail.

FIG. 4 illustrates an example portion of the MSC/VLR of FIG. 1 in greater detail.

FIG. 5 illustrates exemplary operations of the HLR portion of FIG. 3.

FIG. 6 illustrates exemplary operations of the HLR portion of FIG. 8.

FIG. 7 illustrates exemplary operations of the MSC/VLR portion of FIG. 4.

FIG. 8 illustrates another example portion of the HLR of FIG. 1 according to another embodiment of the invention.

FIG. 9 illustrates exemplary operations of the HLR portion of FIG. 8.

DETAILED DESCRIPTION

FIG. 1 illustrates an example of an inter-networking mobile communications arrangement that implements the present invention. In FIG. 1, a mobile subscriber unit MS_H has roamed from the coverage area of its home PLMN, designated in FIG. 1 as HPLMN, into the coverage area of a visited PLMN, designated in FIG. 1 as VPLMN. Conventional examples of the HPLMN and VPLMN of FIG. 1 include GSM, DCS 1800 (Digital Cellular System for Mobile Communications), and PCS (Personal Communica-

tions System). The HPLMN and VPLMN of FIG. 1 can be defined, for example, by any of the foregoing conventional network standards, such conventional networks of course being enhanced as disclosed herein to include the present invention.

Although only pertinent portions of HPLMN and VPLMN are illustrated in FIG. 1 for clarity of exposition, it will be recognized that HPLMN and VPLMN of FIG. 1 represent fully functional PLMNs. For example, the VPLMN includes a home location register HLR (or a suitable equivalent) similar to that shown in the HPLMN, and the HPLMN includes a mobile services switching center and visited location register (collectively designated as MSC/VLR in FIG. 1) similar to that illustrated in the VPLMN. One example of an equivalent alternative to the MSC/VLR of FIG. 1 is an SGSN (Serving GPRS Support Node). As mentioned above, with the exception of the herein described enhancements according to the present invention, the HPLMN and VPLMN of FIG. 1 can be, and for purposes of this description are assumed to be, otherwise conventional.

Mobile subscriber MS_H is shown in broken lines in HPLMN to indicate that it has roamed out of HPLMN and into VPLMN where MS_H is shown to be visiting. Other mobile subscriber units MS are shown in both the HPLMN and the VPLMN. Although the present invention is described with respect to the mobile subscriber unit MS_H , the principles of the invention are equally applicable to any of the mobile subscriber units MS when they roam, for example, outside of their home PLMN.

When MS_H roams into VPLMN, it checks in with MSC/VLR (as is conventional), which requests a Location Update from the HLR of HPLMN using the MAP communications link illustrated diagrammatically at 12 in FIG. 1. MAP refers to conventional Mobile Application Part signaling. This MAP "Location Update" operation is well-known in the art, and provides to HLR current location information regarding MS_H , along with other conventional information. In response to the MAP "Location Update" request, the HLR conventionally responds with a MAP "Insert Subscriber Data" message signaled, for example, over the MAP link 12. According to the invention, the HLR also provides, in the "Insert Subscriber Data" message, information relative to call forwarding/deflecting services, for example, whether or not call forwarding services subscribed to by MS_H are to be barred. The MSC/VLR of VPLMN uses this bar information from HLR to decide whether or not to permit calls for MS_H to be forwarded (or deflected) to another destination, for example at 15, via a communications path 17. The destination 15 could also be located elsewhere, e.g. in another PLMN outside both PLMNs of FIG. 1, or in a Public Switched Telephone Network (PSTN) as shown by broken lines.

FIG. 2 illustrates one example of a memory 21 in the HLR of FIG. 1. The memory 21 has stored therein a database 23 as shown. The database 23 includes information about operator determined barring (ODB) services to which various mobile subscribers have subscribed. Column 25 illustrates the mobile subscriber units (also referred to as mobile stations) $MS1$, $MS2$, etc. which have subscribed to ODB services. Column 27 illustrates the areas (designated $A1$, $A2$, etc. in which the subscribed ODBs are effective, and column 29 illustrates the calls which are barred (designated as Calls1, Calls2, etc.) when the respective mobile stations are located in the respective areas $A1$, $A2$, etc. of column 27.

Examples of the effective areas $A1$, $A2$, etc. in column 27 of FIG. 2 include: outside of the mobile subscriber's

HPLMN coverage area; outside of the mobile subscriber's HPLMN country; and outside of the mobile subscriber's HPLMN zone. Examples of the barred calls represented by Calls1, Calls2, etc. in column 29 of FIG. 2 include: all forwarding calls; all international forwarding calls; all international forwarding calls except those directed to the subscriber's HPLMN country; all inter-zone forwarding calls; and all inter-zone forwarding calls except those directed to the subscriber's HPLMN country. These examples of effective areas and categories of forwarding (or deflecting) calls can be seen to yield, in this example, 15 distinct subscriptions available to the mobile subscribers. More specifically, for each of the aforementioned three effective areas, there are five different categories of calls which can be barred. Of course, the number and definition of effective ODB areas and the number and definition of barred calls categories can be set up as needed by the network operator in order to obtain the ODB functionality that is desired.

FIG. 3 illustrates an example portion 31 of the HLR of FIG. 1. The portion 31 may be used to implement the ODB services defined in FIG. 2. In FIG. 3, a detector 33 receives as inputs the location of the mobile subscriber and the effective bar area, and provides an output signal 35 indicative of whether or not the Mobile subscriber is located in the corresponding bar area. For example, and referring also to FIG. 2, the output signal 35 from the detector 33 would indicate whether or not the mobile station $MS1$ is within the bar area $A1$. If $MS1$ is located in area $A1$, then the output signal 35 will control multiplexer 37 such that the barred calls input of multiplexer 37 is coupled to the output of multiplexer 37. In this example, the barred calls input of multiplexer 37 would be the barred calls definition represented by Calls1 in column 29 of the database 23 in FIG. 2. If $MS1$ is not located in area $A1$, then signal 35 will couple the Null input of multiplexer 37 to the output of multiplexer 37. The Null input indicates that no ODB is to be implemented. The output of multiplexer 37 is provided to VLR (see FIG. 1) as part the MAP "Insert Subscriber Data" message sent over MAP link 12.

FIG. 4 illustrates example portions of MSC/VLR in the VPLMN of FIG. 1. When at 40 the MSC receives a call for MS_H that is to be forwarded (or receives from MS_H a call to be deflected), the call to be forwarded is input to a categorizer 43, which examines and categorizes the call that is to be forwarded. Then, a determiner 45 receives from categorizer 43 a signal 46 indicative of the category of the call. The determiner also receives from VLR an input 41 indicative of any forwarding calls which are barred and thus will not be forwarded from the mobile subscriber unit MS_H . If the determiner 45 determines that the call category as output from categorizer 43 corresponds to the information from VLR regarding the category of calls to be barred, then the output signal 47 from determiner 45 maintains switch 49 in the open position, so that the call is not forwarded to the destination (e.g. 15 of FIG. 1). However, if the determiner 45 determines that the category of the call to be forwarded does not fall within the barred call category information received from VLR, then the output 47 of determiner 45 closes switch 49 to permit the call to be forwarded from the MSC to the destination 15 via the communication path 17 of FIG. 1.

For example, if the output 46 of categorizer 43 indicates that the call at 40 is an international forwarding call directed to the mobile subscriber's HPLMN country, and if the barred call category information 41 from VLR indicates that all international forwarding calls except those directed to the mobile subscriber's HPLMN country are to be barred, then the determiner 45 will close the switch 49 to permit for-

5

warding of the call. On the other hand, using the same call to be forwarded and thus the same output 46 from the categorizer 43, but assuming that the information 41 from VLR indicates that all international forwarding calls are barred, then the determiner 43 will maintain the switch 49 open to prevent the call from being forwarded. Information about the HPLMN and HPLMN country of MS_H is provided by VLR to categorizer 43 at input 44. VLR receives the HPLMN and HPLMN country information from HLR in the MAP "Insert Subscriber Data" message.

FIG. 5 illustrates an example of the ODB control operations implemented by the example HLR portion of FIG. 3. In FIG. 5, it is first determined at 51 whether a MAP "Location Update" message has been received from an MSC/VLR, for example in the VPLMN of FIG. 1. If so, it is then determined at 53 whether or not the mobile subscriber associated with the Location Update message has subscribed to an ODB. If not, then the database 23 of FIG. 2 will yield a null value to be applied to the bar area input of detector 33 in FIG. 3. (For example, if the mobile subscriber has not subscribed to an ODB, then that mobile subscriber would not have a corresponding entry in the database 23, resulting in the null input to detector 33). This null value at the bar area input of detector 33 will cause the detector output 35 to select the null value at multiplexer 37, which step is illustrated at 55 in FIG. 5. Thereafter, at 57 the HLR sends a MAP Insert Subscriber Data message to the MSC/VLR via the MAP signaling link of FIG. 1. Information from this Insert Subscriber Data message, including the null value from multiplexer 37, will be stored in the VLR, and the null value will be provided at 41 to the determiner 45 (see FIG. 4). This null value indicates to the determiner that no ODBs are in effect for the mobile subscriber, so that all calls can be forwarded (or deflected) through the switch 49, regardless of the output 46 from the categorizer.

If at 53 the HLR determines that the mobile subscriber does subscribe to an ODB, then at 59 the detector 33 of FIG. 3 determines whether or not the mobile subscriber is located in an effective bar area. The MS location input to the detector 33 is of course received in the MAP "Location Update" message (see 51). If at 59 the detector 33 determines that the mobile subscriber is not located in the bar area, then the null value is selected at 55 to be output from the multiplexer 37 of FIG. 3, as described above. If at 59 the detector 33 determines that the mobile subscriber is located in the associated bar area, then at 58 the control signal 35 of FIG. 3 causes the multiplexer 37 to select the barred calls information. Thereafter, the Insert Subscriber Data message is sent over the MAP link (see FIG. 1), and the barred calls information is stored in the VLR of the VPLMN.

In FIG. 5 if no "Location Update" message is received at 51, it is determined at 52 whether an ODB subscription request has been received. Such a subscription request is typically done by the operator using the conventional operation and maintenance system. If so, then the ODB subscription is activated at 54, for example, by inserting into the database 23 of FIG. 2 an entry identifying the mobile station, the bar area and the barred calls. Thereafter, the same steps (53, 55, 57, 58 and 59) are executed as described above with respect to the receipt of a "Location Update" message at 51. Thus, when a mobile subscriber that already subscribes to call forwarding (or deflecting) requests an ODB subscription at 52, if that mobile subscriber is in the bar area corresponding to the ODB being subscribed to (see 59), then the barred calls information from the database of FIG. 2 will be transmitted in an Insert Subscriber Data message to the MSC/VLR currently visited by that mobile subscriber (see 57 and 58).

6

FIG. 8 illustrates another example portion 81 of the HLR of FIG. 1 according to another embodiment of the invention. The portion 81 implements the ODB functionality of the present invention without requiring any modifications to the conventional MSC/VLR design. Because the mobile station's call forwarding subscription is conventionally recorded in HLR, the forwarding destination number is already conventionally stored in HLR. Thus, the determiner 83 of FIG. 8 examines the mobile station location information (from the "Location Update" request), the bar area information (from FIG. 2), the barred calls information (from FIG. 2), and the known forwarding destination information, and determines therefrom whether the mobile station is in a barred area and whether a forwarding call to the forwarding destination falls in the barred calls category. The determiner output 85 then selects at multiplexer 87 either a null message or a bar message to be sent to MSC/VLR in the "Insert Subscriber Data" message. Information about whether or not to inhibit call forwarding is conventionally included in the "Insert Subscriber Data" message, for example, the so-called active quiescent state in GSM, so the ODB of the invention can be implemented by suitably communicating the conventional active-quiescent state to a conventional MSC/VLR design.

The example portion 81 of HLR illustrated in FIG. 8 can alternatively be used to approve or deny a request to activate call forwarding services for a mobile subscriber that already subscribes to the ODB services of the invention. For example, if the HLR of FIG. 1 receives a request (see CF request in FIG. 8) from a mobile station (that already subscribes to the ODB service) to activate call forwarding services for that mobile station, then determiner 83 will determine whether or not the mobile station, for example MS1 of FIG. 2, is in its associated bar area, in this example, area A1, and whether or not the barred calls category, in this example Calls1, includes a call to the forwarding destination. If the mobile station is in area A1 (the location of the mobile station is known from the most recent Location Update Message) and the Calls1 category includes calls to the forwarding destination, then the determiner output 85 will control multiplexer 89 (via the broken lines shown in FIG. 8) such that the deny CF input of multiplexer 89 is coupled to the output thereof. Thus, the HLR determines that call forwarding should not be activated for a mobile station which is currently located in an effective bar area according to its own ODB subscription, and whose selected forwarding destination falls within the effective barred calls category of its own ODB subscription. On the other hand, if the determiner 83 does not detect that mobile station MS1 is in area A1, or does not determine that a call to the forwarding destination falls in the Calls1 category, the determiner output 85 controls multiplexer 89 such that the activate call forwarding (ACT.CF) input of multiplexer 89 is coupled to the output thereof. In this manner, the HLR makes the decision of whether or not to activate call forwarding services for the particular mobile subscriber.

FIG. 9 illustrates example operations of the HLR portion 81 of FIG. 8. FIG. 9 is the same as the example of FIG. 5 up to decision block 59. At block 59, if the MS is in the bar area, it is then determined at 56 whether a call to the forwarding destination is in the barred calls category. If so, then the bar message is selected at 50 (see 87 in FIG. 8), and, if not, then the null message is selected at 55 (see 87 in FIG. 8). After the message is selected at 50 or 55, the message is sent at 57 as in FIG. 5.

FIG. 6 illustrates an example of the operation of the HLR portion of FIG. 8 to control activation of call forwarding (or

deflecting) services. At 61, once a request to activate call forwarding is received, it is next determined at 63 whether the requesting mobile subscriber currently subscribes to an ODB. If not, the call forwarding services are activated conventionally at 65, after which the next request to activate call forwarding is awaited at 61. If it is determined at 63 that the requesting mobile subscriber does subscribe to an ODB, it is then determined at 67 whether or not the mobile subscriber is in the bar area associated with the ODB subscription. If not, then the call forwarding services are activated at 65 as above (see 89 of FIG. 8). If the requesting mobile subscriber is in the bar area associated with its own ODB subscription, it is then determined at 62 whether a call to the forwarding destination falls in the barred calls category. If so, then activation of call forwarding services is denied at 69 (see 89 of FIG. 8). If a call to the destination number does not represent a barred call at 62, then call forwarding is activated at 65. Thereafter, the next request for activation of call forwarding is awaited at 61.

FIG. 7 illustrates an example of call forwarding (or deflecting) control operations performed by the MSC/VLR portion shown in FIG. 4. It is first determined at 71 whether the MSC has received a call to be forwarded. If so, then at 73 the categorizer of FIG. 4 categorizes the call, and at 75 the determiner of FIG. 4 determines whether or not call forwarding is barred for that particular call. If call forwarding is barred, then the call forwarding is denied at 77 by leaving the switch of FIG. 4 in the open position. If call forwarding is not barred at 75, then at 79 call forwarding is enabled by closing the switch of FIG. 4. During call forwarding operation, the switch 49 of FIG. 4 remains closed until the forwarded call has been completed, whereupon the switch is reopened and remains so until call forwarding is next enabled. This control of the switch prevents any calls from being forwarded until it is adequately determined that no ODB is applicable to the candidate for forwarding. After the decision to enable or deny call forwarding has been made and the appropriate action taken at 75, 77, and 79, the next candidate for call forwarding is awaited at 71.

By using the location of the mobile subscriber as a trigger to bar call forwarding (or deflecting) without barring all outgoing calls, call forwarding costs for roaming subscribers can be controlled, and fraud can be avoided, without restricting all outgoing calls, or all international calls, and without unconditionally barring call forwarding. The location-triggered ODB can be advantageously implemented by suitably modifying one or more of the conventional HLR, VLR and MSC nodes as needed and, further advantageously, the conventional MAP signaling protocol can be used.

It will be clear to workers in the art that the embodiments of FIGS. 1-9 can be readily implemented, for example, in hardware, or software, or suitable combinations of hardware and software in a conventional HLR, a conventional MSC, and a conventional VLR.

Although exemplary embodiments of the present invention have been described above in detail, this does not limit the scope of the invention, which can be practiced in a variety of embodiments.

What is claimed is:

1. An apparatus for controlling call forwarding service provided to a wireless mobile communication station, comprising:

an input for receiving information indicative of a location of the wireless mobile communication station and for receiving information indicative of a call forwarding bar area, and

a determiner coupled to said input, said determiner having an output responsive to said location information and said call forwarding bar area information for indicating that call forwarding from the wireless mobile communication station is barred, without indicating that other outgoing calls from the wireless mobile communication station are barred.

2. The apparatus of claim 1, wherein said call forwarding bar area is located outside of a coverage area associated with a home mobile communication network of the wireless mobile communication station.

3. The apparatus of claim 1, wherein said call forwarding bar area is located outside of a country in which is located a coverage area associated with a home mobile communication network of the wireless mobile communication station.

4. The apparatus of claim 1, wherein said call forwarding bar area is located outside of a zone in which is included a coverage area associated with a home mobile communication network of the wireless mobile communication station.

5. The apparatus of claim 1, wherein said input is further for receiving call identification information that identifies forwarding calls to be barred, and wherein said output is further responsive to said call identification information for indicating that call forwarding from the wireless mobile communication station is barred.

6. The apparatus of claim 5, including a memory coupled to said input and having stored therein an entry that includes said call forwarding bar area information.

7. The apparatus of claim 6, wherein said entry includes station identification information that identifies the wireless mobile communication station.

8. The apparatus of claim 7, wherein said entry includes said call identification information.

9. The apparatus of claim 5, including a memory coupled to said input and having stored therein an entry which includes said call identification information.

10. The apparatus of claim 9, wherein said entry indicates that all forwarding calls are to be barred.

11. The apparatus of claim 9, wherein said entry indicates that all international forwarding calls are to be barred.

12. The apparatus of claim 9, wherein said entry indicates that all inter-zone forwarding calls are to be barred.

13. The apparatus of claim 1, wherein said determiner is operable for indicating that call forwarding from the wireless mobile communication station to a forwarding destination is barred, without indicating that all other types of outgoing calls from the wireless mobile communication station to said forwarding destination are barred.

14. The apparatus of claim 1, wherein said input is further for receiving information indicative of an area into which call forwarding from the wireless mobile communication station is prohibited when the wireless mobile communication station is located in the call forwarding bar area, said determiner operable in response to said prohibited area information and said call forwarding bar area information and said location information for indicating that call forwarding from the wireless mobile communication station is barred.

15. An apparatus for controlling call forwarding service provided to a wireless mobile communication station, comprising:

an input for receiving information indicative of a location of the wireless mobile communication station; and
an output for indicating, based on the location information, that call forwarding from the wireless mobile communication station to a forwarding destination

9

nation is barred, without indicating that all other types of outgoing calls from the wireless mobile communication station to the forwarding destination are barred.

16. A method of controlling call forwarding service provided to a wireless mobile communication station, comprising:

receiving information indicative of a location of the wireless mobile communication station;

receiving information indicative of a call forwarding bar area; and

indicating, based on the location information and the call forwarding bar area information, that call forwarding from the wireless mobile communication station is barred, without indicating that other outgoing calls from the wireless mobile communication station are barred.

17. The method of claim 16, wherein said call forwarding bar area is located outside of a coverage area associated with a home mobile communication network of the wireless mobile communication station.

18. The method of claim 16, wherein the call forwarding bar area is located outside of a zone in which is included a coverage area associated with a home mobile communication network of the wireless mobile communication station.

19. The method of claim 16, wherein the call forwarding bar area is located outside of a zone in which is included a coverage area associated with a home mobile communication network of the wireless mobile communication station.

20. The method of claim 16, wherein said indicating step includes determining from the location information and the call forwarding bar area information whether the wireless mobile communication station is located in the call forwarding bar area.

21. The method of claim 20, wherein said indicating step includes indicating that call forwarding is barred when (1) the wireless mobile communication station is determined to be located in the call forwarding bar area and (2) a call forwarding destination associated with the mobile station requires a forwarding call that is included in a predetermined category of calls barred to the mobile station while the mobile station is in the call forwarding bar area.

22. The method of claim 16, including identifying forwarding calls which are to be barred.

23. The method of claim 22, wherein said identifying step includes indicating that all forwarding calls are to be barred.

24. The method of claim 22, wherein said identifying step includes identifying all international forwarding calls to be barred.

25. The method of claim 22, wherein said identifying step includes identifying all inter-zone forwarding calls to be barred.

26. The method of claim 16, wherein said indicating step includes indicating that call forwarding from the wireless mobile communication station to a forwarding destination is barred, without indicating that all other types of outgoing calls from the wireless mobile communication station to said forwarding destination are barred.

27. The method of claim 16, including receiving information indicative of an area into which call forwarding from

10

the wireless mobile communication station is prohibited when the wireless mobile communication station is located in the call forwarding bar area, said indicating step including indicating, based on the location information and the call forwarding bar area information and the prohibited area information, that call forwarding from the wireless mobile communication station is barred.

28. A method of controlling call deflecting service provided to a wireless mobile communication station, comprising:

receiving information indicative of a location of the wireless mobile communication station;

receiving information indicative of a call deflecting bar area; and

indicating, based on the location information and the call deflecting bar area information, that call deflecting from the wireless mobile communication station is barred, without indicating that other outgoing calls from the wireless mobile communication station are barred.

29. The method of claim 28, wherein said indicating step includes indicating that call deflecting from the wireless mobile communication station to a deflecting destination is barred, without indicating that all other types of outgoing calls from the wireless mobile communication station to said deflecting destination are barred.

30. The method of claim 28, including receiving information indicative of an area into which call deflecting from the wireless mobile communication station is prohibited when the wireless mobile communication station is located in the call deflecting bar area, said indicating step including indicating, based on the location information and the call deflecting bar information and the prohibited area information, that call deflecting from the wireless mobile communication station is barred.

31. An apparatus for controlling call forwarding service provided to a mobile station, without modifying mobile switching center/visitor location register design, comprising:

an input for receiving information indicative of a location of the mobile station sent from a mobile switching center/visitor location register;

a storage portion for storing therein call forwarding destination information, call forwarding bar area information and barred forwarding calls information associated with the mobile station; and

a determiner coupled to said input and said storage apparatus, said determiner having an output responsive to said location information and said call forwarding bar area information and said barred forwarding calls information for indicating to said mobile switching center/visitor location register that call forwarding from said mobile station is barred, without indicating that other outgoing calls from said mobile station are barred.

32. The apparatus of claim 31, provided in a home location register (HLR).

* * * * *



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(12) **United States Patent**
Havinis et al.

(10) Patent No.: **US 6,463,289 B1**
(45) Date of Patent: **Oct. 8, 2002**

(54) **SYSTEM AND METHOD FOR PROVIDING
RESTRICTING POSITIONING OF A TARGET
MOBILE STATION BASED ON THE
CALCULATED LOCATION ESTIMATE**

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(73) Assignee: Ericsson Inc., Research Triangle Park, NC (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(52) U.S. Cl. 455/456; 455/411; 455/421

(58) Field of Search 342/457; 455/456,
455/422, 428, 433-435, 457, 461, 421,
560, 561, 466; 340/989, 434

(56) **References Cited**

U.S. PATENT DOCUMENTS

| | | | | |
|-------------|---|---------|------------------|---------|
| 5,442,805 A | * | 8/1995 | Sagers et al. | 455/456 |
| 5,682,142 A | * | 10/1997 | Loosmore et al. | 340/572 |
| 5,727,057 A | * | 3/1998 | Emery et al. | 379/211 |
| 5,768,686 A | * | 6/1998 | LeBlanc et al. | 455/456 |
| 5,940,764 A | * | 8/1999 | Mikami | 455/456 |
| 5,950,125 A | * | 9/1999 | Buhrmann et al. | 455/422 |
| 5,960,341 A | * | 9/1999 | LeBlanc et al. | 455/426 |
| 6,011,973 A | * | 1/2000 | Valentine et al. | 455/456 |
| 6,023,624 A | * | 2/2000 | Hanson | 455/458 |
| 6,101,387 A | * | 8/2000 | Granberg et al. | 455/433 |

| | | | | |
|--------------|---|---------|----------------|---------|
| 6,104,931 A | * | 8/2000 | Havinis et al. | 455/456 |
| 6,134,447 A | * | 10/2000 | Havinis et al. | 455/456 |
| 6,138,003 A | * | 10/2000 | Kingdon et al. | 455/410 |
| 6,167,266 A | * | 12/2000 | Havinis et al. | 455/433 |
| 6,181,934 B1 | * | 1/2001 | Havinis et al. | 455/432 |
| 6,195,557 B1 | * | 2/2001 | Havinis et al. | 455/456 |
| 6,212,390 B1 | * | 4/2001 | Rune | 455/456 |
| 6,249,808 B1 | * | 6/2001 | Seshadri | 709/206 |
| 6,256,064 B1 | * | 6/2001 | Monroe | 455/66 |
| 6,272,342 B1 | * | 8/2001 | Havinis et al. | 455/433 |
| 6,295,454 B1 | * | 9/2001 | Havinis et al. | 455/456 |
| 6,347,228 B1 | * | 2/2002 | Ludden et al. | 455/456 |

* cited by examiner

Primary Examiner—Edward F. Urban

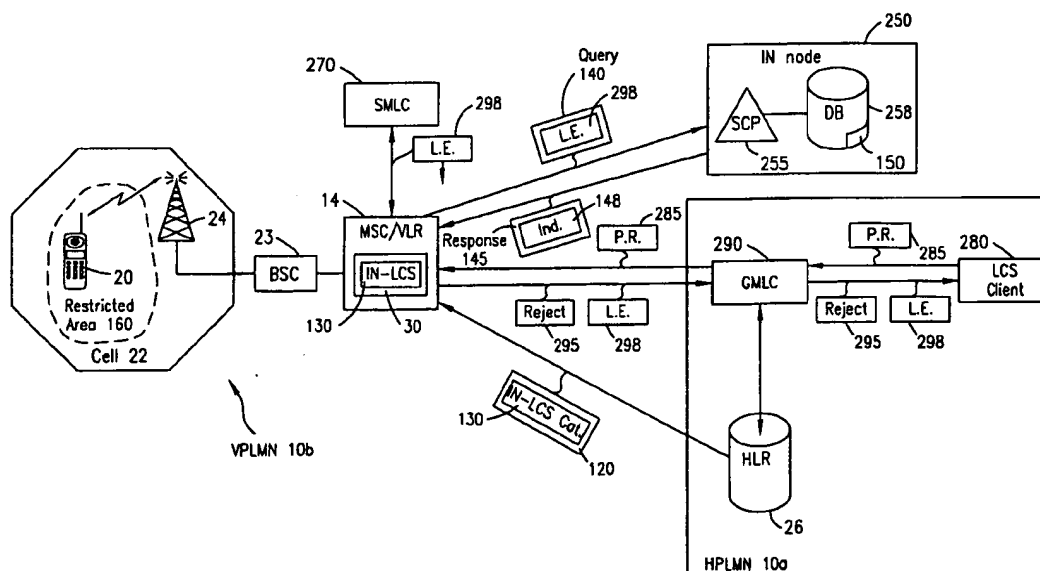
Assistant Examiner—Charles Craver

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(57) **ABSTRACT**

A telecommunications system and method is disclosed for defining restricted positioning areas by geographical location. The restricted area information can be established by the cellular network or the mobile subscriber, and can be stored in a database, such as an Intelligent Network (IN) node. An IN trigger can be included in the subscriber information provided to the serving Mobile Switching Center/Visitor Location Register (MSC/VLR) or the IN trigger can be stored in specific MSC/VLR's that have restricted positioning areas for all mobile subscribers. Upon receiving the calculated location estimate, the IN trigger is activated, and the MSC/VLR transmits the calculated location estimate to the IN node to determine whether the calculated location estimate can be provided to the requesting Location Services (LCS) client based upon the defined restricted positioning area information.

30 Claims, 5 Drawing Sheets



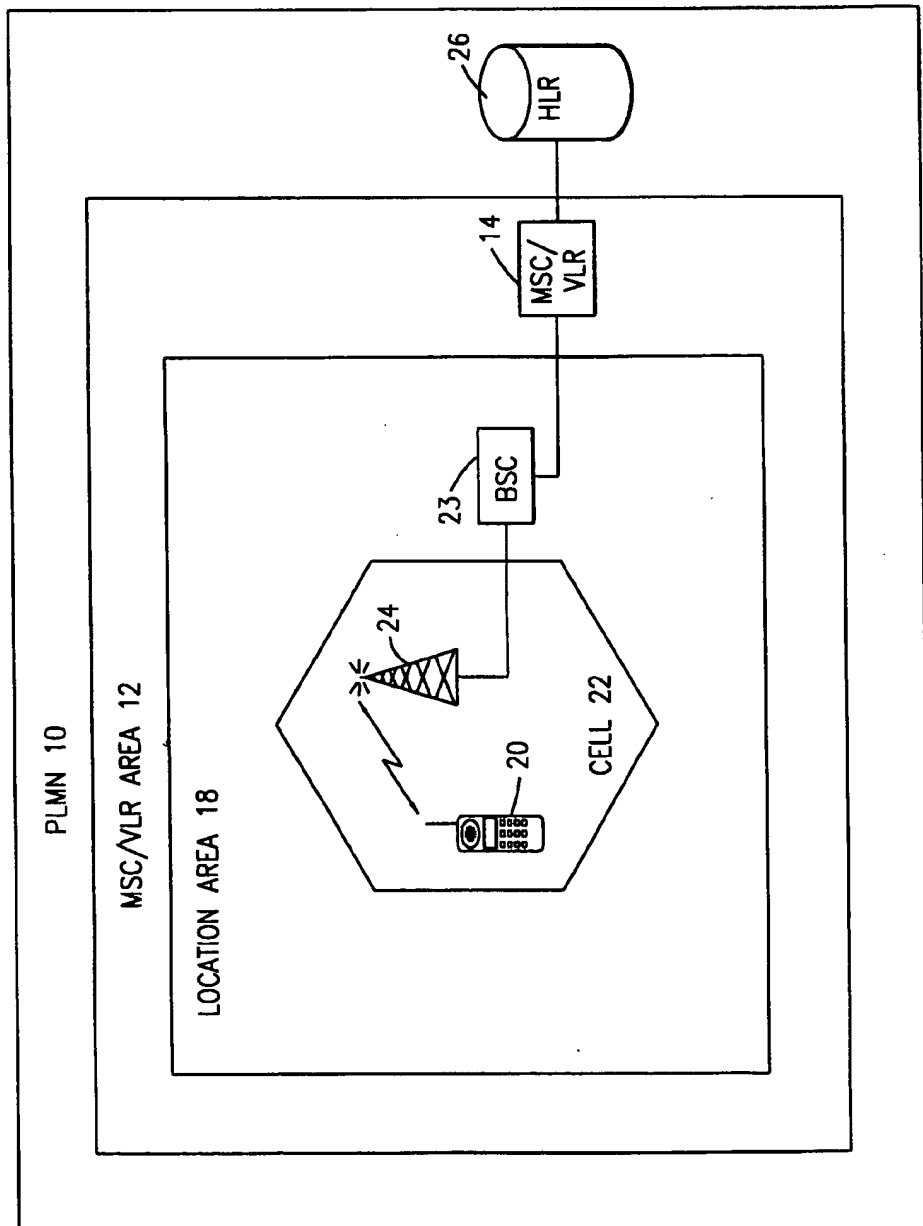


FIG. 1

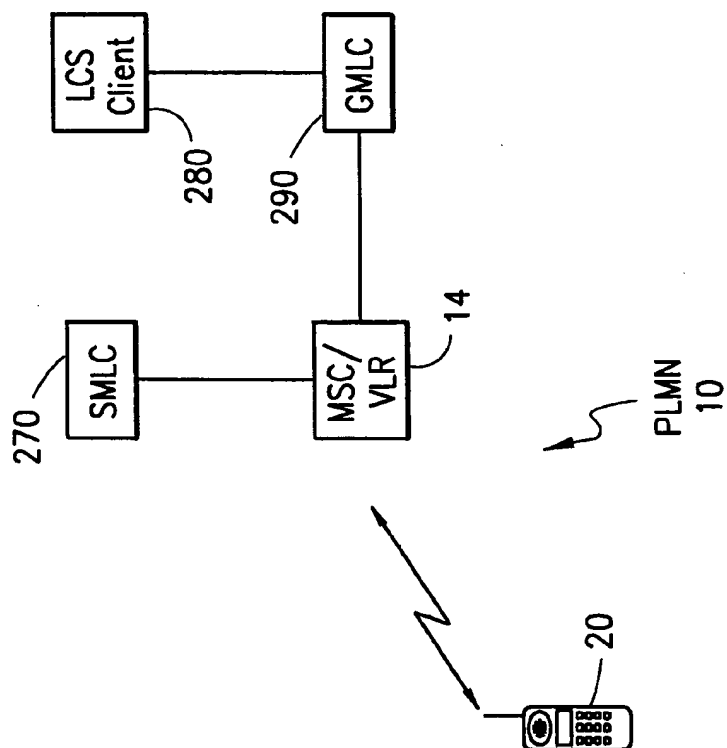


FIG. 2

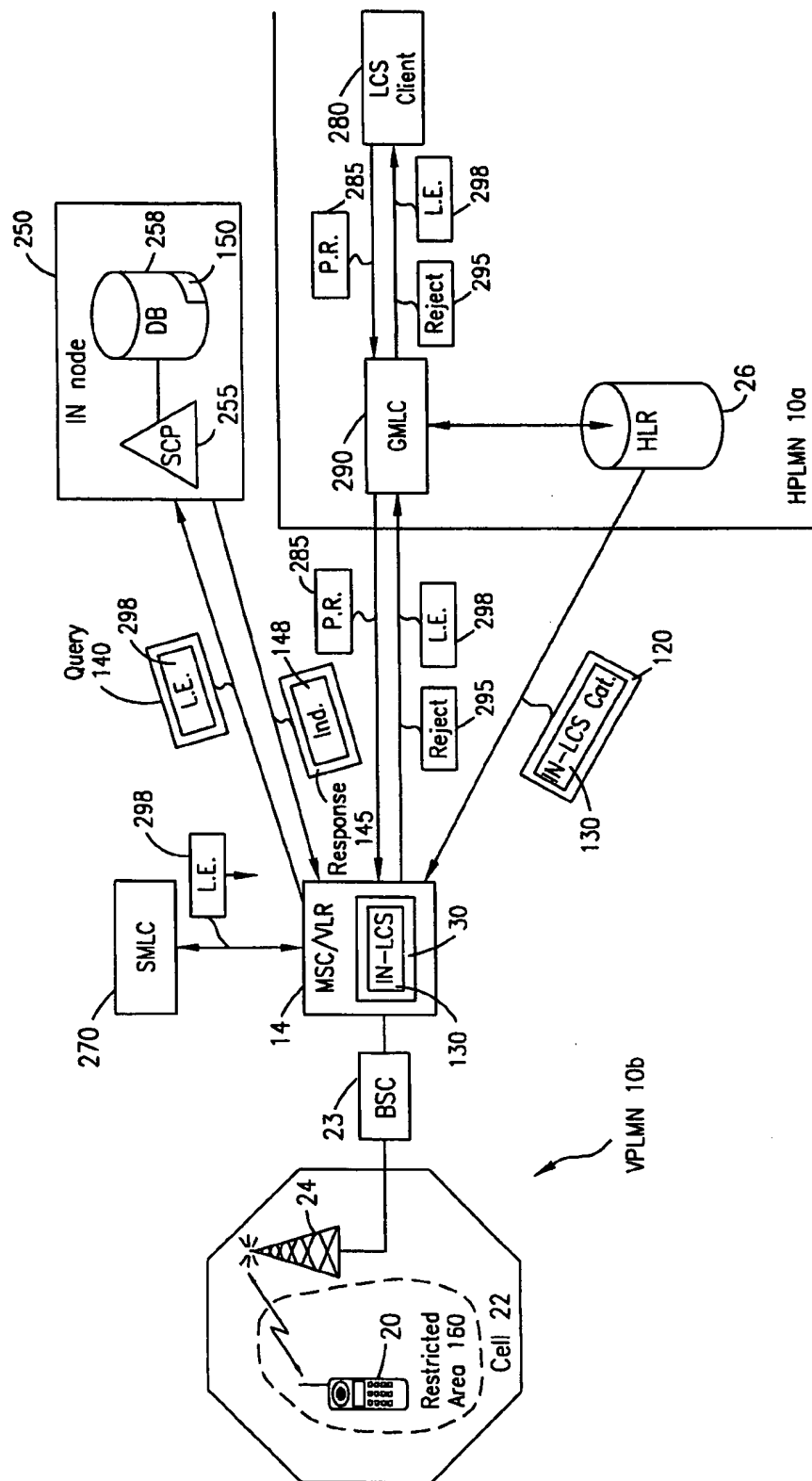
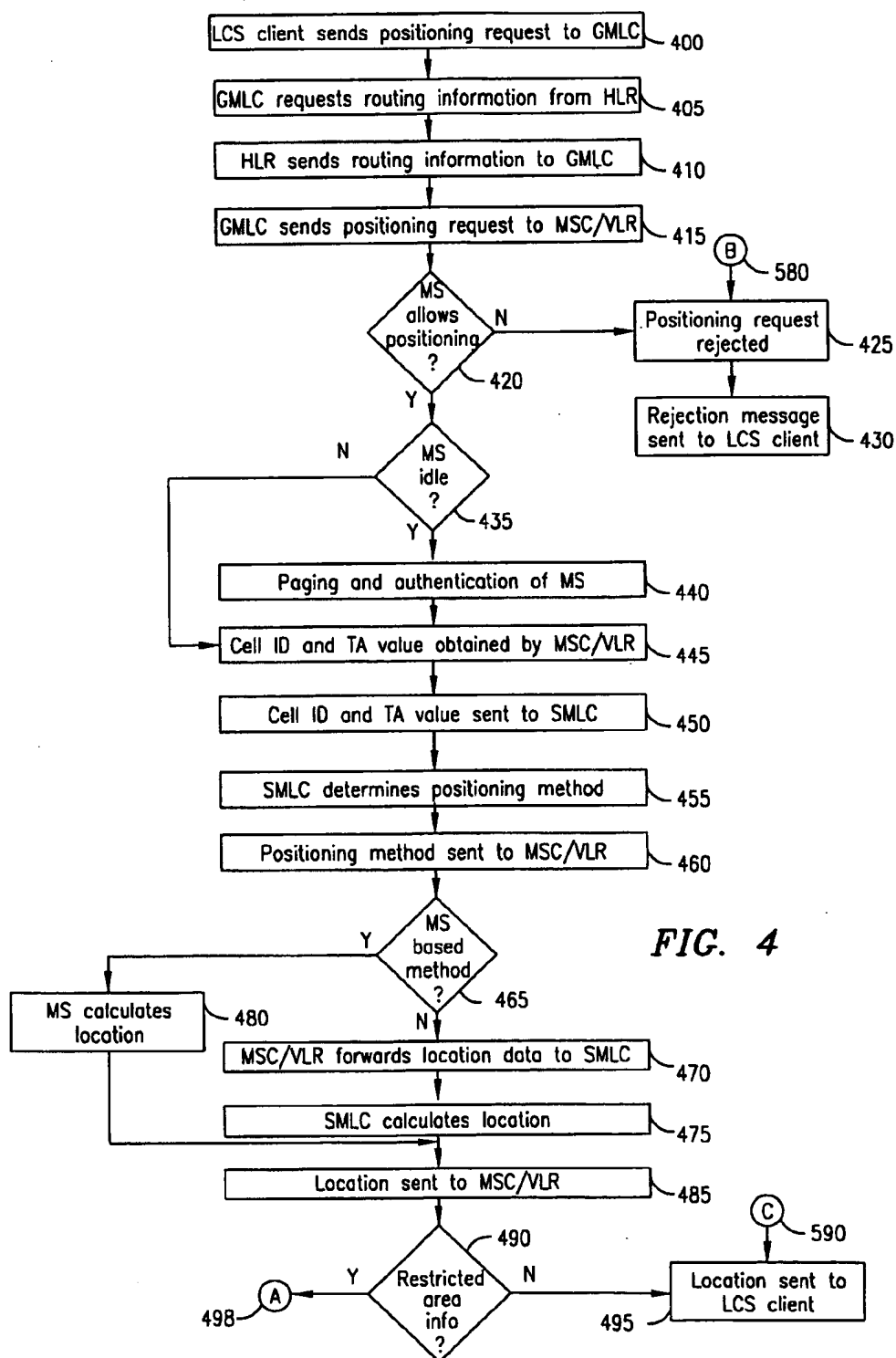


FIG. 3



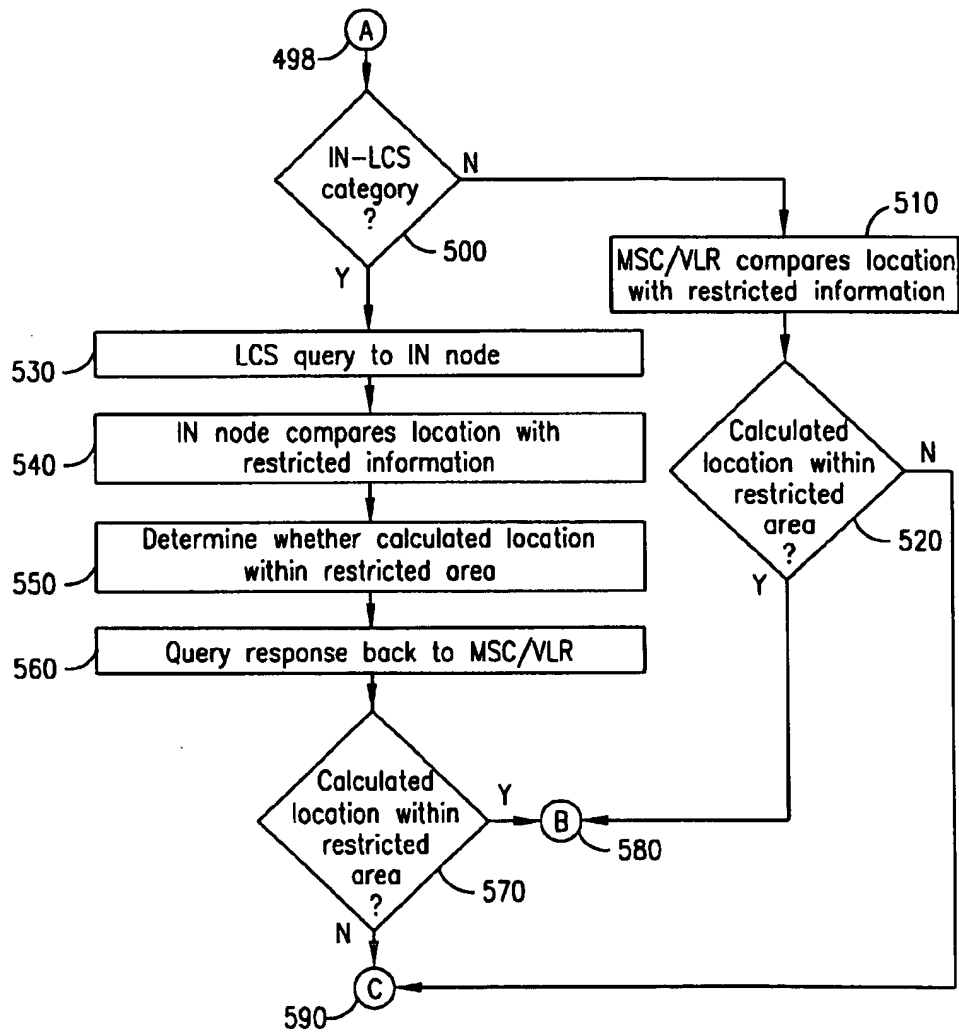


FIG. 5

1

SYSTEM AND METHOD FOR PROVIDING RESTRICTING POSITIONING OF A TARGET MOBILE STATION BASED ON THE CALCULATED LOCATION ESTIMATE

BACKGROUND OF THE PRESENT INVENTION

Field of the Invention

The present invention relates generally to telecommunications systems and methods for positioning a target mobile station within a cellular network, and specifically to providing position related services based on the calculated location of the target mobile station.

BACKGROUND AND OBJECTS OF THE PRESENT INVENTION

Determining the geographical position of an mobile subscriber within a cellular network has recently become important for a wide range of applications. For example, location services (LCS) may be used by transport and taxi companies to determine the location of their vehicles. In addition, for emergency calls, e.g., 911 calls, the exact location of the mobile subscriber may be extremely important to the outcome of the emergency situation. Furthermore, LCS can be used to determine the location of a stolen car, for the detection of home zone calls, which are charged at a lower rate, for the detection of hot spots for micro cells, or for the subscriber to determine, for example, the nearest gas station, restaurant, or hospital, e.g., "Where am I" service.

In some instances, the mobile subscriber or the cellular network currently serving the mobile subscriber may not want to provide the location information to the requesting LCS client. For example, the mobile subscriber may not want his or her location to be provided when that subscriber is at home, at work or at a location that the mobile subscriber would like to restrict positioning. Likewise, the network may not want to provide location information when the mobile subscriber is in an area that requires secrecy, such as a military base, government office, police station or other area that the network would like to restrict positioning.

Currently, to prevent an LCS client from obtaining location information, a mobile subscriber can define a Subscriber Location Privacy Profile (SLPP), which indicates which LCS clients are allowed to position the mobile subscriber and in which locations those LCS clients are allowed to position the mobile subscriber. However, the allowed or disallowed location (s) can only be defined by network area, such as by cell or Location Area (LA), all of which typically cover a large geographical region. This is due to the fact that the SLPP is only used in an initial determination of whether or not the LCS client is allowed to position the mobile subscriber. This determination is typically performed before the geographical location information is calculated, which requires the determination to be made based upon the network area that the mobile subscriber is currently located in.

If the restricted area covers only a portion of a network area, such as a cell, defining an entire network area as a disallowed area unnecessarily prevents an LCS client from obtaining location information. In addition, if the network determines that a portion of a network area should be restricted from positioning, the network must prevent all positioning from being performed in the entire network area. This is undesirable for both the network and the mobile subscriber.

2

SUMMARY OF THE INVENTION

The present invention is directed to telecommunications systems and methods for defining restricted positioning areas by geographical location. The restricted area information can be established by the cellular network or the mobile subscriber, and can be stored in a database, such as an Intelligent Network (IN) node. An IN trigger can be included in the subscriber information provided to the serving Mobile Switching Center/Visitor Location Register (MSC/VLR) or the IN trigger can be stored in specific MSC/VLR's that have restricted positioning areas for all mobile subscribers. Upon receiving the calculated location estimate, the IN trigger is activated, and the MSC/VLR transmits the calculated location estimate to the IN node to determine whether the calculated location estimate can be provided to the requesting LCS client based upon the defined restricted area information.

BRIEF DESCRIPTION OF THE DRAWINGS

The disclosed invention will be described with reference to the accompanying drawings, which show important sample embodiments of the invention and which are incorporated in the specification. hereof by reference, wherein:

FIG. 1 is a block diagram of a conventional cellular network;

FIG. 2 is a block diagram illustrating a cellular network performing a conventional positioning of a mobile subscriber;

FIG. 3 is an exemplary block diagram illustrating a cellular network providing positioning information associated with a mobile subscriber based upon restricted geographical information, in accordance with embodiments of the present invention;

FIG. 4 is a flow chart illustrating the steps involved in positioning a mobile subscriber; and

FIG. 5 is a flow chart illustrating the steps involved in determining whether the calculated location is within the restricted geographical area, in accordance with embodiments of the present invention.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EXEMPLARY EMBODIMENTS

The numerous innovative teachings of the present application will be described with particular reference to the presently preferred exemplary embodiments. However, it should be understood that this class of embodiments provides only a few examples of the many advantageous uses of the innovative teachings herein. In general, statements made in the specification of the present application do not necessarily delimit any of the various claimed inventions. Moreover, some statements may apply to some inventive features but not to others.

With reference now to FIG. 1 of the drawings, there is illustrated a sample cellular network 10, such as a Global System for Mobile Communications (GSM) Public Land Mobile Network (PLMN), which in turn is composed of a plurality of areas 12, each with a Mobile Switching Center (MSC) and an integrated Visitor Location Register (VLR) (MSC/VLR) 14 therein. The MSC/VLR 14 provides a circuit switched connection of speech and signaling information between a Mobile Station (MS) 20 and the PLMN 10. The MSC/VLR areas 12, in turn, include a plurality of Location Areas (LA) 18, which are defined as that part of a given MSC/VLR area 12 in which the MS 20 may move

freely without having to send update location information to the MSC/VLR 14 that controls the LA 18. Each LA 18 is divided into a number of cells 22. The MS 20 is the physical equipment, e.g., a car phone or other portable phone, used by mobile subscribers to communicate with the cellular network 10, each other, and users outside the subscribed network, both wireline and wireless.

The MSC/VLR 14 is in communication with at least one Base Station Controller (BSC) 23, which, in turn, is in contact with at least one Base Transceiver Station (BTS) 24. The BTS is the physical equipment, illustrated for simplicity as a radio tower, that provides radio coverage to the cell 22 for which it is responsible. It should be understood that the BSC 23 may be connected to several BTS's 24, and may be implemented as a stand-alone node or integrated with the MSC/VLR 14.

With further reference to FIG. 1, the PLMN Service Area or cellular network 10 includes a Home Location Register (HLR) 26, which is a database maintaining all subscriber information, e.g., user profiles, current location information, International Mobile Subscriber Identity (IMSI) numbers, and other administrative information, for subscribers registered within that PLMN 10. The HLR 26 may be co-located with a given MSC/VLR 14, integrated with the MSC/VLR 14, or alternatively can service multiple MSC/VLRs 14.

As can be seen in FIG. 2 of the drawings, for conventional positioning of a particular MS 20, upon the reception of a positioning request from a Location Services (LCS) client 280, the MSC/VLR 14 sends a Mobile Application Part (MAP) PERFORM LOCATION message to a Serving Mobile Location Center (SMLC) 270 within the PLMN 10 associated with the MSC/VLR 14. The SMLC 270 is responsible for carrying out the positioning request and calculating the MS 20 location. Thereafter, the SMLC 270 determines the positioning method to use. For example, the SMLC 270 can use a number of different positioning mechanisms, including, but not limited to, Timing Advance (TA), Time of Arrival (TOA), Enhanced Observed Time Difference (E-OTD) or Global Positioning System (GPS).

After the SMLC 270 determines the positioning method to use, the SMLC 270 instructs the MSC/VLR 14 to obtain raw location data using the determined positioning method and return this raw location data to the SMLC 270. Thereafter, the SMLC 270 calculates the MS 20 location and returns this location estimate to the MSC/VLR 14. In turn, the MSC/VLR 14 forwards the location estimate to the LCS client 280 that requested the positioning. It should be noted that the requesting LCS client 280 could be located within the MS 20 itself, within the MSC/VLR 14 or could be an external node, such as an Intelligent Network (IN) node. If the LCS client 280 is not within the MS 20 or within the MSC/VLR 14, the location estimate is sent to the requesting LCS client 280 via the MSC/VLR 14 and a Gateway Mobile Location Center (GMLC) 290.

With reference now to FIG. 3 of the drawings, in order to restrict the positioning of a mobile subscriber within a specific geographical area 160, restricted area information 150 associated with the geographical area 160 can be defined by either the network operator or the mobile subscriber. If the restricted area information 150 is defined by the network operator, the restricted area information 150 can be valid for any mobile subscriber being positioned within the restricted geographical area 160. In addition, this restricted area information 150 can be stored in the MSC/VLR 14 serving the restricted area 160 or within an external node, such as an IN node 250, the latter being illustrated.

However, if the restricted area information 150 is defined by the mobile subscriber, this restricted area information 150 only applies to that mobile subscriber. In this case, the restricted area information 150 can be stored in the HLR 26 associated with the mobile subscriber or within the IN node 250, the latter being illustrated. The restricted area information 150 could be, for example, a set of coordinates, a set of coordinates along with a defined radius around that set of coordinates or at least three sets of coordinates that define the geographical area 160 encompassed by the restricted area information 150.

When an MS 20 first registers with a serving MSC/VLR 14, which could be in the home PLMN 10a or within a visiting PLMN 10b, the latter being illustrated, the MS 20 sends a location updating message to the MSC/VLR 14. In response, the MSC/VLR 14 sends an update location message to the HLR 26, which returns subscriber information associated with the MS 20 back to the MSC/VLR 14 in an Insert Subscriber Data message 120.

If the mobile subscriber has defined at least one restricted geographical area 160, the restricted area information 150 can be passed back to the MSC/VLR 14 in the Insert Subscriber Data message 120 and stored in a subscriber record or database 30 associated with the MS 20 within the MSC/VLR 14. Alternatively, and preferably, instead of sending the restricted area information 150 directly to the MSC/VLR 14, the HLR 26 can send a new subscriber IN-LCS category 130 in the Insert Subscriber Data message 120. The IN-LCS category 130 serves as an IN trigger to the IN node 250 housing the restricted area information 150. It should be understood that if the PLMN 10b defined the restricted area information, the IN-LCS category 130 would be provided to the MSC/VLR 14 by the PLMN 10b and stored in the database 30 in the MSC/VLR 14.

With reference now to the steps shown in FIG. 4 of the drawings, which will be described in connection with FIG. 3 of the drawings, once the MS 20 is registered with the MSC/VLR 14, an LCS client 280 can send a positioning request 285, which specifies the particular Mobile Station Integrated Services Digital Network (MSISDN) number associated with the particular target MS 20 to be positioned, to the GMLC 290 within the PLMN 10a of the LCS client 280 (step 400). It should be noted that the positioning request 285 can also include the duration and/or number of positionings to be performed.

When the GMLC 290 receives the positioning request 285, the GMLC 290 sends a request for routing information (step 405), e.g., the address of the serving MSC/VLR 14 within the PLMN 10b that the MS 20 is currently located in, to the HLR 26 associated with the MS 20, using the MS's 20 directory number as a global title. In response, the HLR 26 retrieves routing information for the MS 20 and sends this routing information to the GMLC 290 (step 410). Using this routing information, the GMLC 290 transmits a MAP_PROVIDE_SUBSCRIBER_LOCATION message, which contains the positioning request 285, to the serving MSC/VLR 14 (step 415).

Thereafter, the MSC/VLR 14 verifies that the MS 20 allows positioning to be performed (step 420), e.g., by checking privacy information, such as the Subscriber Location Privacy Profile (SLPP), which is also sent to the MSC/VLR 14 by the HLR 26 in the Insert Subscriber Data message 120. If the MS 20 does not allow positioning (step 420), the positioning request 285 is rejected (step 425) and a rejection message 295 is sent to the LCS client 280 (step 430).

However, if the MS 20 does allow positioning (step 420), and the MS 20 is in idle mode (step 435), the MSC/VLR 14 performs paging and authentication of the MS 20, along with ciphering of the positioning data (step 440). This procedure provides the MSC/VLR 14 with the identification (ID) of the current cell 22 that the MS 20 is located in, along with a Timing Advance (TA) value for the serving BTS 24 (step 445). However, if the MS 20 is in dedicated mode (step 435), e.g., involved in a call connection, the MSC/VLR 14 obtains the current cell 22 ID and TA value for the serving BTS 24 from the serving BSC 23 (step 445).

Upon receipt of the current cell 22 ID and TA value (step 445), the MSC/VLR 14 sends a MAP_PERFORM_LOCATION message, which includes the current cell 22 ID and TA value, to the SMLC 270 associated with the MS's 20 current cell 22 ID (step 450). Thereafter, the SMLC 270 determines the positioning method to use, e.g., Timing Advance (TA), Time of Arrival (TOA), Enhanced Observed Time Difference (E-OTD) or Global Positioning System (GPS) (step 455).

Once the SMLC 270 determines the appropriate positioning method, the SMLC 270 sends to the MSC/VLR 14 the chosen positioning method and any assistance data that the MS 20 might need if the MS 20 has the capability to position itself (step 460). Thereafter, if the chosen positioning method does not involve the MS 20 positioning itself (step 465), as is shown in FIG. 3, the MSC/VLR 14 obtains raw location data, such as TA values from neighboring BTSs (not shown), and forwards this raw location data to the SMLC 270 (step 470) for calculation of the geographical location estimate 298, e.g., X, Y coordinates, of the MS 20 (step 475). Otherwise, the MS 20 uses the assistance data provided by the SMLC 270 to calculate its own location 298 (step 480). This location estimate 298 is passed back to the MSC/VLR 14 (step 485), which normally forwards the location estimate 298 to the requesting LCS client 280 (step 495) via the GMLC 290.

However, if the MS 20 or visiting PLMN 10b has defined restricted area information 150 (step 490), upon receiving the location estimate 298, a determination is made of whether the calculated location estimate 298 is within the geographical area 160 encompassed by the restricted area information 150 (step 498). With reference now to the steps listed in FIG. 5 of the drawings, if the MS 20 or MSC/VLR 14 does not have the IN-LCS category 130 associated therewith (step 500), but rather the restricted area information 150 is stored in the MSC/VLR 14, the MSC/VLR 14 compares the calculated location estimate 298 with the restricted area information 150 (step 510) to determine if the calculated location estimate 298 is within the restricted geographical area 160 (step 520).

If the MS 20 or MSC/VLR 14 does have the IN-LCS category 130 associated therewith (step 500), the IN-LCS category 130 within the MSC/VLR 14 triggers the MSC/VLR 14 to send an LCS query 140 (step 530), including the location estimate 298, to the IN node 250 that stores the restricted area information 150 for the MS 20 or MSC/VLR 14. It should be understood that the IN node 250 could be, for example, a Service Control Point (SCP) 255 within the IN that has access to a database 258 that stores the restricted area information 150.

In response, the IN node 250 compares the calculated location estimate 298 with the restricted area information 150 (step 540) to determine whether the calculated location estimate 298 is within the restricted positioning area 160 (step 550). After the determination is made, the IN node 250

sends a query response 145 back to the MSC/VLR 14 (step 560), including an indication 148 indicating whether or not the calculated location estimate 298 is within the restricted area 160. By removing the restricted area information 150 to the IN node 250, the comparison and determination processes do not need to be performed by the MSC/VLR 14, which reduces the burden on the MSC/VLR 14.

If the indication 148 indicates that the calculated location estimate 298 is within the restricted area 160 (step 570), or the MSC/VLR 14 determines that the calculated location estimate 298 is within the restricted area 160 (step 520), as shown in FIG. 4 of the drawings (step 580), the MSC/VLR 14 rejects the positioning request 285 (step 425) and sends the rejection message 295 to the LCS client 280 (step 430). Otherwise (step 590), as shown in FIG. 4 of the drawings, the MSC/VLR 14 transmits the location estimate 298 to the requesting LCS client 280 (step 495) via the GMLC 290.

As will be recognized by those skilled in the art, the innovative concepts described in the present application can be modified and varied over a wide range of applications. Accordingly, the scope of patented subject matter should not be limited to any of the specific exemplary teachings discussed, but is instead defined by the following claims.

What is claimed is:

1. A telecommunications system for restricting positioning of a mobile station within a cellular network, comprising:
 - a database for storing restricted area information associated with a geographical area unrelated to any network area defined by said cellular network; and
 - a mobile switching center in wireless communication with said mobile station for receiving a positioning request for said mobile station, determining a location estimate for said mobile station and accessing said database to determine whether said location estimate is within said geographical area encompassed by said restricted area information, said mobile switching center rejecting said positioning request in response to a determination that said location estimate is within said geographical area encompassed by said restricted area information.
2. The telecommunications system of claim 1, wherein said database is within said mobile switching center.
3. The telecommunications system of claim 1, wherein said database is an Intelligent Network node.
4. The telecommunications system of claim 3, wherein said Intelligent Network node includes a database accessible by a Service Control Point.
5. The telecommunications system of claim 3, wherein said mobile switching center has an Intelligent Network Location Services category stored therein, said Intelligent Network Location Services category triggering a query to said Intelligent Network node upon determination of said location estimate.
6. The telecommunications system of claim 5, wherein said query includes said location estimate.
7. The telecommunications system of claim 6, wherein said Intelligent Network node compares said location estimate with said restricted area information to determine if said location estimate is within said geographical area encompassed by said restricted area information.
8. The telecommunications system of claim 7, wherein said Intelligent Network node transmits a query response to said mobile switching center, said query response including an indication of whether or not said location estimate is within said geographical area encompassed by said restricted area information.
9. The telecommunications system of claim 8, wherein said mobile switching center rejects said positioning request

7

when said indication indicates that said location estimate is within said geographical area encompassed by said restricted area information.

10. The telecommunications system of claim 5, wherein said Intelligent Network Location Services category is associated with said mobile station.

11. The telecommunications system of claim 5, wherein said Intelligent Network Location Services category is associated with said mobile switching center.

12. A telecommunications system for restricting positioning of a mobile station within a cellular network, comprising:

an Intelligent Network node for storing restricted area information associated with a geographical area unrelated to any network area defined by said cellular network, said Intelligent Network node further for receiving a query including a location estimate for said mobile station, determining whether said location estimate is within said geographical area encompassed by said restricted area information and transmitting a query response including an indication of whether or not said location estimate is within said geographical area encompassed by said restricted area information; and

a mobile switching center in wireless communication with said mobile station for receiving a positioning request for said mobile station, determining said location estimate for said mobile station, sending said query including said location estimate to said Intelligent Network node and receiving said query response from said Intelligent Network node, said mobile switching center rejecting said positioning request when said indication indicates that said location estimate is within said geographical area encompassed by said restricted area information.

13. The telecommunications system of claim 12, wherein said Intelligent Network node includes a database accessible by a Service Control Point.

14. The telecommunications system of claim 12, wherein said mobile switching center has an Intelligent Network Location Services category stored therein, said Intelligent Network Location Services category triggering said query to said Intelligent Network node upon determination of said location estimate.

15. The telecommunications system of claim 14, wherein said Intelligent Network Location Services category is associated with said mobile station.

16. The telecommunications system of claim 14, wherein said Intelligent Network Location Services category is associated with said mobile switching center.

17. A method for restricting positioning of a mobile station within a cellular network, comprising the steps of:

receiving a positioning request for said mobile station at a mobile switching center in wireless communication with said mobile station;

determining a location estimate for said mobile station; comparing said location estimate with restricted area information associated with a geographical area unrelated to any network area defined by said cellular network; and

in response to a determination that said location estimate is within said geographical area encompassed by said restricted area information, rejecting said positioning request by said mobile switching center.

18. The method of claim 17, further comprising the step of:

8

in response to said step of determining, sending a query including said location estimate from said mobile switching center to an Intelligent Network node.

19. The method of claim 18, wherein said step of comparing is performed by said Intelligent Network node.

20. The method of claim 19, further comprising the step of:

transmitting a query response from said Intelligent Network node to said mobile switching center, said query response including an indication of whether or not said location estimate is within said geographical area encompassed by said restricted area information.

21. The method of claim 17, wherein said restricted area information is associated with said mobile station.

22. The method of claim 17, wherein said restricted area information is associated with said mobile switching center.

23. A method for a mobile switching center to restrict positioning of a mobile station in wireless communication with said mobile switching center within a cellular network, comprising the steps of:

receiving a positioning request for said mobile station at said mobile switching center;

determining a location estimate for said mobile station; in response to said step of determining, sending a query including said location estimate to an Intelligent Network node;

receiving a query response from said Intelligent Network node, said query response indicating whether said location estimate is within a geographical area encompassed by restricted area information, said restricted area information being unrelated to any network area defined by said cellular network; and

if said query response indicates that said location estimate is within said geographical area encompassed by said restricted area information, rejecting said positioning request by said mobile switching center.

24. The method of claim 23, wherein said step of sending further comprises the step of:

triggering an Intelligent Network Location Services category stored within said mobile switching center to send said query in response to said step of determining.

25. The method of claim 24, wherein said Intelligent Network Location Services category is associated with said mobile station.

26. The method of claim 24, wherein said Intelligent Network Location Services category is associated with said mobile switching center.

27. A method for restricting positioning of a mobile station within a cellular network, comprising the steps of:

receiving a positioning request for said mobile station at said mobile switching center;

determining a location estimate for said mobile station; in response to said step of determining, sending a query including said location estimate to an Intelligent Network node;

comparing said location estimate with restricted area information stored within said Intelligent Network node, said restricted area information being associated with a geographical area unrelated to any network area defined by said cellular network;

determining whether said location estimate is within said geographical area encompassed by said restricted area information;

transmitting a query response from said Intelligent Network node to said mobile switching center, said query

9

response indicating whether said location estimate is within said geographical area encompassed by restricted area information; and

if said query response indicates that said location estimate is within said geographical area encompassed by said restricted area information, rejecting said positioning request by said mobile switching center.

28. The method of claim 27, wherein said step of sending further comprises the step of:

triggering an Intelligent Network Location Services category stored within said mobile switching center to

10

send said query in response to said step of determining said location estimate.

29. The method of claim 28, wherein said Intelligent Network Location Services category is associated with said mobile station.

30. The method of claim 28, wherein said Intelligent Network Location Services category is associated with said mobile switching center.

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